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NATIONAL
ELECTRIC LIGHT
ASSOCIATION.

Thirteenth Convention,
Providence, R. I.,
Feb. 17, 18, 19, '91.

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NATIONAL
Electric Light
ASSOCIATION.

THIRTEENTH CONVENTION.

PROVIDENCE, R. I.,
February 17th, 18th and 19th, 1891.

PUBLISHED BY ORDER OF THE EXECUTIVE COMMITTEE.

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Nationa
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CONVENTIONS OF THE ASSOCIATION.

First,	Chicago, February 25, 26, 1885.
Second,	New York, August 18, 19, 20, 1885.
Third,	Baltimore, February 10, 11, 12, 1886.
Fourth,	Detroit, August 31, September 1, 2, 1886.
Fifth,	Philadelphia, February 15, 16, 17, 1887.
Sixth,	Boston, August 9, 10, 11, 1887.
Seventh,	Pittsburgh, February 21, 22, 23, 1888.
Eighth,	New York, August 29, 30, 31, 1888.
Ninth,	Chicago, February 19, 20, 21, 1889.
Tenth,	Niagara Falls, August 6, 7, 8, 1889.
Eleventh,	Kansas City, February 11, 12, 13, 14, 1890.
Twelfth,	Cape May, August 19, 20, 21, 1890.
Thirteenth,	Providence, February 17, 18, 19, 1891.

PRESIDENTS OF THE ASSOCIATION.

JAMES F. MORRISON, of Baltimore.
SAMUEL A. DUNCAN, of Pittsburgh.
EDWIN R. WEEKS, of Kansas City.
MARSDEN J. PERRY, of Providence.

HONORARY MEMBERS.

R. E. Crompton, London, Eng.
Marcel Deprex, Membre de l'Institut, Paris, France.
George D. Forbes, London, Eng.
Prof. I. Fujioka, Tokio, Japan.
Z. T. Gramme, Paris, France.
Dr. C. Herz, 31 Boulevarde des Italiens, Paris, France.
Dr. John Hopkinson, London, Eng.
Edouard Hospitalier, Paris, France.
Dr. E. L. Nichols, Cornell University, Ithaca, N. Y.
Baron Alphonse de Rothschild, Paris, France.
John T. Sprague, Birmingham, Eng.
Joseph W. Swan, Lauriston, Bromley, Kent, Eng.
Prof. Silvanus P. Thomson, Technical College, Finsbury, London, Eng.
Prof. Yashima, Tokio, Japan.
Sir William Thomson, Glasgow, Scotland.
Prof. Henry A. Rowland, Johns Hopkins University, Baltimore, Md.
Charles F. Brush, Cleveland, Ohio.
Thomas A. Edison, Orange, N. J.
Prof. Elihu Thomson, Lynn, Mass.
Frank J. Sprague, New York City.
George S. Bowen, New York City.
Edward Weston, Newark, N. J.

ACTIVE MEMBERS.

Albany, N. Y., Albany Electric Illuminating Company.
Asbury Park, N. J., Asbury Park Electric Light and Power Company.
Attleboro, Mass., North Attleboro Steam and Electric Company.
Baltimore, Md., The Brush Electric Company of Baltimore City.
Boston, Mass., Boston Electric Light Company.
 The Edison Electric Illuminating Company of Boston.
Bridgeport, Conn., Bridgeport Electric Light Company.
Brookline, Mass., Brookline Gas Light Company.
Brooklyn, N. Y., Citizens' Electric Illuminating Company.
 Edison Electric Illuminating Company of Brooklyn.
 Municipal Electric Light Company.
Buffalo, N. Y., Brush Electric Light Company.
 Thomson-Houston Electric Light and Power Company of Buffalo.
 The United States Electric Light and Power Company.
Camden, N. J., Camden Lighting and Heating Company.
 Camden Horse Railroad Company.
Canton, Mass., Blue Hill Electric Company.
Charleston, S. C., Charleston Light and Power Company.
Chicago, Ill., Chicago Arc Light and Power Company.
 Electric Illuminating Company.
Cincinnati, O., The Cincinnati Electric Light Company.
Crestline, O., Cantine & Company.
Danbury, Conn., Danbury and Bethel Gas and Electric Light Company.
Denver, Colo., The Denver Consolidated Electric Company.
East Saginaw, Mich., Swift Electric Light Company.
Eau Claire, Wis., Eau Claire Street Railway, Light and Power Company.
Elizabeth, N. J., Elizabeth Schuyler Electric Company.
Fitchburg, Mass., Fitchburg Gas and Electric Light Company.
Green Bay, Wis., Green Bay and Fort Howard Electric Light Company.
Holyoke, Mass., Holyoke Water Power Company.
Houghton, Mich., Peninsula Electric Light and Power Company.
Johnson City, Tenn., Watauga Lighting and Power Company.
Kansas City, Mo., Kansas City Electric Light Company.
 Metropolitan Street Railway Company.
Lancaster, Pa., Edison Electric Illuminating Company of Lancaster.
Malden, Mass., Malden Electric Light Company.
Manchester, N. H., Manchester Electric Light Company.
Memphis, Tenn., Memphis Light and Power Company.
Milwaukee, Wis., Badger Illuminating Company.
 Milwaukee Electric Light Company.
Minneapolis, Minn., Minnesota Brush Electric Company.

New Bedford, Mass., New Bedford Gas Light Company.
Newburgh, N. Y., Newburgh Electric Light and Power Company.
New Castle, Pa., New Castle Electric Company.
New Orleans, La., Louisiana Electric Light Company.
New York City, Manhattan Electric Light Company, Limited.
    The Mount Morris Electric Light Company.
Norwalk, O., Norwalk Light and Power Company.
Old Town, Me., Old Town Electric Company.
Pawtucket, R. I., Pawtucket Gas Company.
Philadelphia, Pa., The Brush Electric Company.
    The Keystone Light and Power Company.
    The Philadelphia Electric Lighting Company.
    United States Electric Lighting Company.
Pittsburgh, Pa., The Allegheny County Light Company.
Poughkeepsie, N. Y., Poughkeepsie Electric Light and Power Company.
Providence, R. I., Narragansett Electric Lighting Company.
Rutland, Vt., Rutland Electric Light Company.
Rochester, N. Y., Brush Electric Light Company.
San Francisco, Cal., California Electric Light Company.
Sewickley, Pa., Sewickley Electric Company.
Springfield, Ill., Springfield Electric Light and Power Company.
Stamford, Conn., The Stamford Electric Lighting Company.
St. Louis, Mo., Municipal Electric Lighting and Power Company.
Taunton, Mass., Taunton Electric Lighting Company.
Toledo, O., Western Electric Light and Power Company.
Toronto, Canada, Toronto Incandescent Electric Light Company.
Union Hill, N. J., Heisler Electric Light Company.
Urbana, O., Urbana Electric Light and Power Company.
Utica, N. Y., The Utica Electric Light Company.
Warrensburg, Mo., Warrensburg Electric Company.
Waterbury, Conn., The Connecticut Electric Company.
Waterville, Ont., Canadian Electric Construction, Manufacturing and Supply Company.
Williamsport, Pa., Edison Electric Illuminating Company.
Woodstock, Ont., Woodstock Electric Light and Street Railway Company.
Woonsocket, R. I., Woonsocket Electric Machine and Power Company.
Worcester, Mass., Worcester Electric Light Company.
Zanesville, O., Zanesville Electric Light Company.

ASSOCIATE MEMBERS.

Altoona, Pa., W. H. Markland.
Boston, Mass., American Circular Loom Company.
  Albert & J. M. Anderson.
  Bernstein Electric Company.
  Electric Mutual Insurance Company.
  Eastern Electric Cable Company.
  Employers' Liability Assurance Corporation.
  David J. Cartwright.
  Germania Electric Company.
  Modern Light and Heat.
  Page Belting Company.
  Pettingell-Andrews Company.
  Practical Electricity.
  Russell Electric Company.
  Standard Electric Supply Company.
  Thomson-Houston Electric Company.
  T. M. Foote Regulator Company.
  The Holtzer-Cabot Electric Company.
  The Gould & Watson Company.
  Wright Electrical Engineering Company.
Bridgeport, Conn., Bridgeport Brass Company.
  The Bryant Electric Company.
Chicago, Ill., Chicago Rawhide Manufacturing Company.
  Electrical Industries.
  Electric Merchandise Company.
  Great Western Electric Supply Company.
  Globe Light & Heat Company.
  George Cutter.
  Illinois Electrical Material Company.
  The Electrical Supply Company.
  The Sperry Electric Company.
  Western Electric Company.
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Cleveland, Ohio, Brush Electric Company.
  Hill Clutch Works.
  Globe Carbon Company.
  Standard Carbon Company.
  The Swan Lamp Company.
  The National Carbon Company.
Columbus, O., Jeffrey Manufacturing Company.

Cuyahoga Falls, O., Falls Rivet & Machine Company.
Dayton, O., Stillwell & Bierce Manufacturing Company.
Eau Claire, Wis., National Electric Manufacturing Company.
Erie, Pa., Ball Engine Company.
Fitchburg, Mass., Fitchburg Steam Engine Company.
Fort Wayne, Ind., Fort Wayne Electric Company.
  Charles S. Bradley.
Fremont, O., Thomson-Houston Carbon Company.
Geneva, O., Forest City Electric Works.
Gloucester, Mass., Thermal Electric Company.
Hartford, Conn., F. C. Rockwell.
  The Johns-Pratt Company.
  Jewell Belting Company.
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La Plata, Argentine Republic, Frank Cassels.
Lockport, N. Y., American District Steam Company.
Manchester, Conn., The Mather Electric Company.
Meriden, Conn., L. E. Wilcox & Company.
Middletown, Conn., The Schuyler Electric Company.
Newark, N. J., Baker & Company.
  The C. McIntire Company.
  Weston Electrical Instrument Company.
New Britain, Conn., T. H. Brady.
New Haven, Conn., Standard Electric Time Company.
New York City, Alexander, Barney & Chapin.
  "C. & C." Electric Motor Company.
  Chas. A. Schieren & Company.
  Consolidated Fruit Jar Company.
  Electric Construction and Supply Company.
  Electric Secret Service Company.
  Electric Power Publishing Company.
  E. P. Gleason Manufacturing Company.
  Electrical Review Publishing Company.
  Empire City Electric Company.
  Engineering Equipment Company.
  Excelsior Electric Company.
  Field Engineering Company.
  H. Ward Leonard.
  India Rubber and Gutta Percha Insulating Company.
  Interior Conduit and Insulation Company.
  John A. Roebling's Sons Company.
  National Electric Protector Company.
  Otto A. Moses.
  Phœnix Glass Company.
  The Ansonia Brass and Copper Company.
  The Babcock & Wilcox Company.
  The Butler Hard Rubber Company.
  The Electrical Age.
  The Electrical Engineer.
  The E. S. Greeley & Company.

New York City, The International Okonite Company.
The Mitchell-Vance Company.
The Norwich Insulated Wire Company.
The *Power* Publishing Company.
The Safety Insulated Wire and Cable Company.
The Standard Paint Company.
The Walker Electric Company.
The W. J. Johnston Company, Limited.
Universal Arc Lamp Company.
C. S. Van Nuis.
Washburn & Moen Manufacturing Company.
Westinghouse, Church, Kerr & Company.
Wm. J. Hammer.
North East, Pa., Eureka Tempered Copper Company.
Philadelphia, Pa., Alfred F. Moore.
H. T. Paiste.
Jas. W. Queen & Company.
Partrick & Carter.
The Thomson-Houston Electric Light Company.
Pittsburgh, Pa., M. W. Mead, Superintendent Bureau of Electricity.
Standard Underground Cable Company.
Providence, R. I., American Electrical Works.
Armington & Sims Engine Company.
A. W. Harris Oil Company.
Dennison Electrical Manufacturing Company.
Drake, Payson & Whittier.
New England Butt Company.
Providence Steam Trap Company.
Swarts & Gannett.
St. Louis, Mo., Parker-Russell Mining and Manufacturing Company.
Pond Engineering Company.
Shultz Belting Company.
Taunton, Mass., Universal Loom Company.
Trenton, N. J., Crescent Insulated Wire and Cable Company.
Washington, D. C., Royce & Marean.
Wilmot Lake.
George C. Maynard.
Windsor, Conn., The Eddy Electric Manufacturing Company.

Committee on Exhibits and Transportation.

Gen. C. H. Barney, *Chairman,*
20 Cortlandt Street, New York City.

Henry B. Cram,	Boston, Mass.
Van. A. Thomas,	Providence, R. I.
William J. Hammer,	New York City.
George C. Maynard,	Washington, D. C.
William A. Kreidler,	Chicago, Ill.
Luke Lilley,	Cincinnati, Ohio.

Reception Committee.

Eugene F. Phillips, *Chairman.*

William G. Nightingale,
Richard H. Deming,
James Richardson, Jr.,
Gardiner C. Sims,
Gen. Elisha Dyer, Jr.,
Ex-Mayor William S. Hayward,
Mortimer H. Hartwell,
Ex-Mayor Henry R. Barker,
Ex-Gov. Herbert Warner Ladd,
Albert C. White,
Geo. H. Wood,
Henry A. DuVillard,
Col. Isaac M. Potter,
Homer M. Daggett, Jr.,
Gen. William Ames,
Col. Arthur H. Watson.

OFFICERS AND EXECUTIVE COMMITTEE.

Officers.

Marsden J. Perry,	President.
E. A. Maher,	First Vice-President.
C. L. Edgar,	Second Vice-President.
Allen R. Foote,	Secretary and Treasurer.

Executive Committee.

Elected at the Twelfth to serve until the close of the Thirteenth Convention.

C. R. Huntley, Chairman.

J. J. Burleigh,
M. J. Francisco,
John A. Seely,
E. R. Weeks,
Edward A. Leslie,*
A. F. Mason,
A. J. De Camp,
C. H. Wilmerding.

Executive Committee.

Elected at the Thirteenth to serve until the close of the Fourteenth Convention.

J. J. Burleigh, Camden, N. J.
A. M. Robertson, Minneapolis, Minn.
E. W. Rollins, Denver, Colo.

Executive Committee.

Elected at the Thirteenth to serve until the close of the Fifteenth Convention.

Albert J. Corriveau, Montreal, Can.
H. H. Fairbanks, Worcester, Mass.
A. J. De Camp, Philadelphia, Pa.

Executive Committee.

Elected at the Thirteenth to serve until the close of the Sixteenth Convention.

E. F. Peck, Brooklyn, N. Y.
John A. Seely, New York, N. Y.
Charles R. Faben, Toledo, O.

---

* Elected in place of James English, resigned.

COMMITTEES

TO REPORT TO THE THIRTEENTH CONVENTION.

Relation between Manufacturing and Central Station Companies.

Marsden J. Perry, Chairman.
A. J. De Camp, F. A. Gilbert,
E. R. Weeks, J. E. Lockwood,
E. A. Armstrong.

Committee on Data.

A. J. De Camp, Chairman.
C. R. Huntley, E. R. Weeks,
E. F. Peck, T. Carpenter Smith.

Copper Tariff.

Charles A. Brown, Chairman.
George M. Phelps.

Underground Conduits and Conductors.

C. H. Wilmerding, Chairman.
T. Carpenter Smith, J. E. Lockwood,
David G. Evans, S. S. Wheeler.

The Proper Classification of the Lighting Power of Incandescent Lamps.

Louis Bell, Chairman.
Allan V. Garratt, P. H. Alexander.

National Insurance Rules.

George Cutter, Chairman.
C. J. Field, H. Ward Leonard,
T. Carpenter Smith, S. E. Barton.

World's Columbian Fair.

Marsden J. Perry, Chairman.
P. H. Alexander, S. J. Hart,
George B. Edwards, George C. Roe.

Legislation.

Hon. E. A. Armstrong, Chairman.

Alabama.	
Arkansas.	
California,	George C. Roe, San Francisco.
Colorado,	C. H. Smith, Denver.
Connecticut,	John C. English, New Haven.
Delaware.	
Florida.	
Georgia,	H. E. W. Palmer, Atlanta.
Illinois,	C. H. Wilmerding, Chicago.
Indiana,	John Caven, Indianapolis.
Idaho.	
Iowa.	
Kansas,	L. A. Beebe, Hutchinson.
Kentucky,	A. H. Barret, Louisville.
Louisiana,	S. J. Hart, New Orleans.
Maine,	William R. Wood, Portland.
Maryland.	
Massachusetts,	F. A. Gilbert, Boston.
Michigan,	J. E. Lockwood, Detroit.
Minnesota.	
Mississippi.	
Missouri,	Joseph A. Corby, St. Joseph.
Montana.	
Nebraska.	
Nevada.	
New Hampshire,	Alonzo Elliott, Manchester.
New Jersey,	E. A. Armstrong, Camden.
New York,	E. A. Maher, Albany.
North Carolina,	David A. Tompkins, Charlotte.
North Dakota,	Vincent S. Stone, Fargo.
Ohio,	Charles R. Faben, Jr., Toledo.
Oregon,	Parker F. Morey, Portland.
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South Dakota.	
Tennessee.	
Texas.	
Vermont,	M. J. Francisco, Rutland.
Virginia.	
West Virginia,	John B. Garden, Wheeling.
Wisconsin,	S. S. Badger, Milwaukee.
Washington.	
Wyoming.	
District of Columbia,	George C. Maynard, Washington.

ORDER OF BUSINESS.

TUESDAY, FEBRUARY 17, 1891.

FIRST SESSION, 11 A. M.

1. Address of Welcome.
   By HON. CHAS. SYDNEY SMITH, Mayor of Providence.
2. Annual Address.
   By MARSDEN J. PERRY, President of the Association.
3. Announcements.
   By the Secretary.
4. Recommendations.
   By the President.
5. Report. Committee on Copper Tariff.
   CHARLES A. BROWN, Chairman.
6. Paper, "Electric Lighting as applied to Steam Railroads."
   By W. H. MARKLAND.

SECOND SESSION, 4 P. M.

7. Report. Committee on Underground Conduits and Conductors.
   C. H. WILMERDING, Chairman.
8. Paper, "Distribution of Steam from a Central Station."
   By F. H. PRENTISS.
9. Report. Committee on Relation between Manufacturing Companies and Central Stations.
   MARSDEN J. PERRY, Chairman.
10. Report. Municipal Control of Electric Railroads.
    By M. W. MEAD.
11. Report. Committee on National Insurance Rules.
    GEORGE CUTTER, Chairman.

MINUTES.

OPENING OF CONVENTION.

The Association met at the Masonic Temple, Tuesday, February 17, 1891, and was called to order by the President, Marsden J. Perry, at 11.15 A. M.

THE PRESIDENT: *Gentlemen of the National Electric Light Association:* It is very gratifying, indeed, to me to meet you here at my own home. Already I discern evidences of earnest purpose that will accomplish most excellent work before we go hence.

I have great pleasure in now introducing to you Hon. Charles Sydney Smith, Mayor of the City of Providence, who will bid you a formal welcome to the city. (Applause.)

ADDRESS OF WELCOME.

BY MAYOR SMITH, OF PROVIDENCE.

Mr. President, Ladies and Gentlemen: I esteem it a high compliment, the kindness which your President has bestowed upon me in asking me to extend to you a cordial welcome to our city. My fellow citizens feel highly honored by your presence among us. I wish very much that the conditions overhead might have been more pleasant, less tearful. I certainly wish that your semi-annual convention might have been held here in the summer months, when we could have shown you an institution peculiar to ourselves, and to which I very much doubt that the application of electricity as a motive power would have in any way improved, to wit, our method of despatching clams. (Laughter.) It is an institution peculiar to Rhode Island. Our city is large in population, has industries diversified, and some of them of the finest and many of them of the largest, I think, in the world. We are, perhaps, not so thoroughly acquainted with the subjects which you will discuss as we ought to be, or as many of us desire to be. There is an element in our community, like all others, fearful of its results. Some men, by reason of their habits of life, I may say, are always fearful of death; men often flee when no one pursueth—"The wicked flee when no man pursueth." Before you get through with your convention I hope you will be able to tell us whether there is any danger in that matter which we are so earnestly discussing at the present day, namely, the application of electricity as a motive power to street cars. We need it very much in some form or other, and we are only endeavoring to find out if death will ensue hourly by its application. (Laughter.)

Gentlemen, the subjects which you are to discuss I have no knowledge of and am entirely unacquainted with them. Sometimes I speak upon matters of which I have no knowledge, but it is never when I know it. Therefore, I shall not undertake to discuss these subjects, but undoubtedly before your convention closes I shall know more than I do to-day about them. I have, therefore, prepared no remarks, but simply desire to express our gratification that you have assembled with us, and to express to you the pleasure which it will afford us to show you through our manufacturing industries, and also leaving you to the tender care and the loyal service which I know that your committee will render to you in making your stay agreeable and pleasant, and, I hope, profitable.

Again, Mr. President and gentlemen, I thank you for this kindness. (Applause.)

ANNUAL ADDRESS.

By Marsden J. Perry, *President.*

At this, our Thirteenth Convention, we have a double duty to perform—a duty to the past, a duty for the future. We who are absorbed in dealing with the problems of to-day, and in attempting to reach a little way into the future by anticipating the demands that may be made upon us, can well afford to pause a moment to pay a fitting tribute to those whose labors in the past have made our present possible.

We are here to pay to the pioneers of the electrical industries a tribute of intelligent appreciation of intelligence, and to recognize in a formal manner the magnificent realization of the inventor's hopes and the scientist's dreams, to erect a milestone that shall mark the closing of the first decade of the practical commercial application of electricity, a development which has shown grander results than ever before known in the industrial history of the world. I ask you to step back a few years, to the time when no electrical work, as we now know it, was in existence, and from that standpoint measure the meaning and value of what has since been done.

We are told that Franklin's kite experiment was made in 1752, and that in 1753 he invented the lightning rod. The age of electricity may be reckoned from that date.

In the year 85 A. F. (after Franklin), the first electrical company in the world was incorporated by a charter granted by the State of Rhode Island. This charter was granted in June, 1838, to E. J. Mallett and his associates, successors and assigns, by whose genius it was conceived, and what became of those aborigines of the electrical age I cannot tell you. That Mr. Mallett and his associates, whoever they were—no other name is mentioned in the charter—, were true prophets of science and industry is unmistakably shown in their marvelous conception of the possibilities of their undertaking. The third section of their charter is as follows:

"The said corporation shall have power to cause experiments to be made in electro-magnetism, magnetism and galvanism, with a view of the development of said sciences as a motive power for machinery or other useful purposes; also to manufacture the necessary machinery and other apparatus therefor; to build and construct boats, vessels, railroad cars and engines, to be moved by electro-magnetism or galvanism."

Has any one to-day a broader view of the possibilities of electric power than this?

In selecting Providence for the meeting place of your Thirteenth Convention you builded better than you knew. You not only at this time celebrate the first decade of electric lighting, but you celebrate it in the birthplace of far-reaching appreciation of electric power.

In the year 91 A. F., Morse constructed the first practical telegraph line. He connected Washington with Baltimore by telegraph in 1844. Seven years before that he exhibited his telegraph in the University of New York. Between invention and success there were seven years of working and waiting.

In the year 113 A. F., Field laid the first successful ocean cable in 1866. Eight years before a cable was laid which operated but a few weeks. Before success there were eight years of patient, courageous work, such as man has seldom had the power to endure.

In the year 122 A. F., Bell gave the telephone to society in 1875, and made all the people of the town neighbors. His years of faithful work preceding crowning success are well remembered.

In the year 125 A. F., Brush exhibited a light that caused people to think the sun had forgotten to set at the ordained hour. The first time the public ever saw lamps burning in series was at the exhibition of the American Institute, held at New York, September 11 to November 23, 1878.

Two isolated plants were then sold, consisting of a six light Brush dynamo and six series lamps. One went to Messrs. Losier & Co., dry goods merchants, of Brooklyn, N. Y.; the other went to Messrs. Freeland, Loomis & Co., Continental Clothing House, in Boston, Mass.

The first arc light central station was installed by the California Electric Light Company, of San Francisco, in 1879.

In the year 127 A. F., Edison divided the electric current and produced miniature suns that might be placed wherever more light was desired for use or pleasure.

The first Edison isolated plant was installed in 1880, in the printing establishment of the Hinds & Ketchum Company, Brooklyn, N. Y. A paragraph in a circular issued by this company, under date of February 1, 1881, is as follows:

"Our building is 40x160, four floors, lighted on all sides and fitted throughout with Edison incandescent lights, operated by a special dynamo electric machine, operated on the premises. We are the first manufacturers in the world to put into practical operation this great triumph of American genius, which is a true substitute for daylight, showing all colors in their natural hues, and our friends are invited to call and see the operation of Professor Edison's wonderful subdivision of the electric current and vacuum lamp."

Mr. Hinds writes: "I think the proudest moment of my life was when I turned on the switch for the first time and saw the room lighted up by what seemed to be the greatest wonder of the world—the incandescent lamp."

The first steamship electric plant was one of Edison's, installed with 120 lamps in the steamship "Columbia," of the Oregon Railroad and Navigation Company, January 10, 1881.

The first Edison central station was installed, with 4,000 lamps, in Pearl street, New York City, September 4, 1882. To start this plant Edison had to overcome more than electrical, mechanical and financial difficulties. He had New York Aldermen to deal with. The following occurs in an interview with Edison, published in the New York *Herald*, January 20, 1881:

"When will you be ready to light New York?" Edison replies: "I am ready now, but we have no permit. I find it hard to get the requisite aldermanic conditions. The company laid an application before the board, the application was referred to the laws committee, and was reported back saddled with conditions which savor of a body of gas men rather than public servants. They wanted, in the first place, the company to pay 10 cents per lineal foot for all wire laid down. That would be 20 cents for every foot of street, for we would run wires on both sides. That is over $1,000 a mile. This, too, when gas companies pay not a cent. The second clause was that we should light the streets at 10 per cent above actual cost. The third clause was that after five years, three per cent. of gross receipts shall go to the city."

This is an example of encouragement given by the first city in America to American genius, skill and enterprise.

Ten years ago the only electric currents in use were the feeble currents of the telegraph and telephone. There was then not a lineman, nor a workman of any kind, who had ever heard of the high tension currents we are using to-day for the services of light and power. No man had ever handled conductors carrying such currents, nor manufactured apparatus for operating them, excepting in an experimental way. There was not an educational institution giving a course of technical training in electrical engineering. Consider this, then behold what has been accomplished in the first decade of electric lighting. A period of time no longer than Morse, Field and Bell were compelled to wait and work to span the chasm lying between invention and practical success.

Confine your observations exclusively to the United States, and you will find the electric light in use by 6,000 isolated plants; 700 steamboats of American register; 350 gas companies furnishing electric light and power; 200 street railroads operated by electric power; 1,500 electric lighting and power stations. Facts like these need no embellishment to make them eloquent.

Now, look beyond the limits of this country and see the development of electrical industry throughout the world during the first decade. Never before has such a transformation taken place. And this is not the end—it is but the beginning of things that are to be.

American genius, skill and pluck has, in all departments of industry, secured within this century benefits of high value for all mankind. That this truth may be known for all time, it is our duty to preserve in the most enduring and instructive form proper records of the achievements of all American industrial pioneers. Soon a fitting opportunity will present itself for the celebration of the first 100 years of American invention by duly honoring the beginning of the second century of the American patent system. In that grand marshalling of those who made prophecies and fulfilled them, who had the genius to see, and the skill, courage and patience to execute, we must see to it that electrical workers occupy their rightful place of honor. The interest begun here should reach full tide then, and should culminate in placing in the National Museum, at Washington, a collection of drawings, models, relics, etc., illustrating the birth and development of electrical industries in America. Such a collection should give at a glance to the unskilled workman or the general public an intelligent idea of successive steps of progress and invention and construction, that have led from the beginning of the telegraph and telephone to those systems of communication as at present perfected ; from the first production of an electric spark to the light we now have; from the first lifting of a weight by an electric magnet to the present marvelous manifestations of electric power. It is of the highest importance that such a collection be made and preserved, not alone for the instruction of the people of our own time, but as history for our successors, written in the forms of the things we use, thus enabling future investigators to determine the relative influence of the electrical industries in forming the character of our civilization, and in enhancing the degree of our prosperity.

One point is worthy of emphasis while engaged in this review; this is the year 138 after Franklin. Would society consent to be placed back to the conditions it was in when Franklin made his kite experiment, if it could thereby recover from the pioneers in electrical work all that they have personally retained from the wealth that has been created by developments from their initial undertakings? No ; not for a single day. They have given to society benefits a thousand times more valuable than all they have received, or that it is possible to confer upon them. Their services are of that divine order in the measuring of which money values are impotent. Limits of time and space are unknown to them. They are with us, and of us, but they take cognizance of no country, no race or generation. Their field is the universe. The benefits of their service are for all men. They receive tribute of grateful honor from all intelligence. Their work is of the past. Our work is from the future.

What report shall be made at the celebration of the close of the second decade of electric lighting and power? The first Edison station has increased its capacity from 4,000 to 15,000 lamps in eight years. At this rate of increase this plant will be supplying 60,000 lamps 10 years hence. We cannot measure the limits of future developments. We have done much, but we have produced only a sample of what is to be. An observer states that there is not a plant in existence having a sufficient capacity to supply one-twentieth of the demand for light and power that now exists within practical working limits of its area of distribution. If this be true, then, within 10 years, if each station is fully to occupy its territory and keep pace with the growth of population, its capacity must be increased many times.

The central station men of this country do not realize the possibilities of development that lie before them. They do not see many sources of income that are as yet untouched. The accelerated pace at which progress is now moving will render the work of the next 10 years enormously greater than all that was accomplished during 138 years after Franklin. The car of progress will not stop for us any more than it did for those who were before us. We have given it momentum, but we cannot hinder it. Let it be our ambition, then, as it is our duty, to supply every demand for every kind of light and power service within reach of our stations. Those of you who do not do this will induce competitors to come within your limits, to divide your business and erect an obstacle in the way of your growth, that can be overcome only by buying out or selling to the intruder. To-day the whole territory is yours to hold, to occupy, to serve. Be the equal of your opportunity, and at the second decennial celebration of electric light and power, the capacity of your plant may be many times what it is to-day.

The records of the beginning of the electrical industries are being written for the imperishable pages of history. We have gained the strength of the difficulties that have been overcome. Like the armies of volunteers that made ours a free nation, the forces now engaged in electrical work were recruited from every vocation. To-day over 30 educational institutions of high grade are preparing the best brains among young men to do scientific and technical work. The practical American workman, who has proven by what he has done that his rank is second to none, the peer of skilled workmen of the world, is educating his helpers and associates in the practical school of daily occupation.

Enterprise is ever young; we are incidents, while an industry, like human energy and force, will go on forever; when we tire and seek our rest, younger men will be eager to fill our places. Let us, then, begin where we may. Let us honor ourselves by fulfilling our double duty, which is to duly honor those who have placed us under obligations for the work they have done in the past, and so to do our work that our successors shall have equal cause for honoring us.

I now declare the Thirteenth Convention to be opened for the transaction of business. Announcements will be made by the secretary.

ANNOUNCEMENTS.

THE SECRETARY: I have received a number of invitations to be extended to the members of the Association, which I will read:

PROVIDENCE TELEPHONE CO.,
PROVIDENCE, R. I.

To the Members of the National Electric Light Association.

GENTLEMEN: In the name and behalf of the Providence Telephone Company, I have the pleasure to tender to the delegates and others of the electrical profession in attendance on the Annual Convention of the National Electric Light Association, fraternal and cordial greetings; and to place our rooms and the facilities of our exchange at their service during their stay in our city.

Congratulating you on the present encouraging aspect, and trusting the meeting will amply fulfill your just expectation, I remain,

Yours very truly,
HENRY HOWARD, *President.*

PROVIDENCE, R. I., February 16, 1891.

To the Members of the National Electric Light Association.

GENTLEMEN: The Union Club of Providence respectfully tender the freedom and hospitality of their club house to the members of your Association, during the week of its Thirteenth Convention.

For the Union Club,
GARDINER C. SIMS, *Vice-President.*

The club house is situated corner of Washington and Aborn Streets. (Applause.)

PROVIDENCE BOARD OF TRADE,
PROVIDENCE, R. I.

Marsden J. Perry, President National Electric Light Association.

DEAR SIR: It is a matter for congratulation that the reputable Association, of which you are the honored president, should select our city as the place for holding their annual meeting this year. The presence of so many men who have become eminent in the development and promotion of electricity in its manifold practical adaptations makes them distinguished visitors, and the Providence Board of Trade desires to place at their disposal the use of its rooms, where they will find all the newspapers, as well as complete telegraphic quotations and other business facilities which may be useful to them while tarrying with us, and they will be cordially welcome to avail themselves of these accommodations.

Very truly yours,
C. H. GEORGE, *President.*

(Applause.)

AMERICAN ELECTRICAL WORKS,
PROVIDENCE, R. I.

To Members of the National Electric Light Association.

GENTLEMEN: Our offices will be turned into reception rooms during the Electric Light Celebration and Convention, to be held in Providence, February 17, 18 and 19, 1891.

Representatives of the company will be pleased at any time to extend courtesies to members of the Association and their friends who may visit us.

Very truly yours,
AMERICAN ELECTRICAL WORKS,
E. F. PHILLIPS, *President.*

ARMINGTON & SIMS ENGINE CO.,
PROVIDENCE, R. I.

To Members of the National Electric Light Association.

GENTLEMEN: We take pleasure in extending the freedom of our works to the members of the National Electric Light Association and their friends at any time, but most especially during their Convention to be held in this city.

We have made many new departures in the way of steam engineering, and now build 51 sizes of electrical engines. Although our works are driven to their utmost capacity, we will make an effort to have some engines running as well for inspection during the Association season.

Sincerely yours,
GARDINER C. SIMS.

NEW ENGLAND BUTT CO.,
PROVIDENCE, R. I.

To Members of the National Electric Light Association.

GENTLEMEN: I am pleased to extend to the members of your Association my cordial invitation to visit our establishment at any time during their attendance on the Convention to be held in this city, February 17, 18 and 19, 1891.

Yours truly,
NEW ENGLAND BUTT CO.,
H. N. FENNER, *Secretary.*

RHODE ISLAND LOCOMOTIVE WORKS,
PROVIDENCE, R. I.

To Members of the National Electric Light Association.

GENTLEMEN: We are informed that you are to hold a Convention in Providence, February 17, 18 and 19, 1891.

Thinking that some members and friends may be interested in visiting some of the industrial establishments in the city during their stay here, we cordially invite all who will kindly do so to visit our works.

Yours truly,

EARL PHILLIP MASON, *Vice-President.*

GORHAM MANUFACTURING CO.,
PROVIDENCE, R. I.

To Members of the National Electric Light Association.

GENTLEMEN: We are informed by Mr. Eugene F. Phillips, Chairman of the Local Reception Committee, that you are to hold an Annual Convention in Providence, February 17, 18 and 19, 1891.

If it is your purpose to visit some of the representative industrial establishments of our city, you will kindly include among the number that of the Gorham Company. It will afford us much pleasure to receive members or their friends, and to have them inspect our new plant at Elmwood.

Yours truly,

GORHAM MANUFACTURING CO.,

J. F. P. LAWTON, *Secretary.*

AMERICAN SCREW CO.,
PROVIDENCE, R. I.

To Members of the National Electric Light Association.

GENTLEMEN: Through the courtesy of Mr. Eugene F. Phillips, Chairman of the Reception Committee, we are glad to inform you that it will give us much pleasure to have members of the National Electric Light Association and their friends, while in convention in this city, during the third week of February, visit our works, and we hope you will accept our invitation most cordially extended.

Yours truly,

OLNEY ARNOLD, *Secretary.*

BROWN & SHARPE MANUFACTURING CO.,
PROVIDENCE, R. I.

To Members of the National Electric Light Association.

GENTLEMEN: Desiring to have a share in the hospitality to be extended to the members of the Association and their friends who attend the Thirteenth Convention, to be held at Providence, we shall be greatly pleased to receive a visit from all interested in mechanical establishments. We will take pleasure in showing the manner in which we manufacture our machinery and tools.

We trust we shall be visited by a large number of representatives of the Association.

Yours truly,

BROWN & SHARPE MANUFACTURING CO.,

Z. CHAFEE, *Secretary.*

THE CORLISS STEAM ENGINE CO.,
PROVIDENCE, R. I.

To Members of the National Electric Light Association.

GENTLEMEN: We hereby extend a cordial invitation to the members of the National Electric Light Association to visit our works at their convenience, during the session of their Convention, to be held next week in this city.

We will be pleased to show all members of the Association who are not competitors, or representatives of competitors, in our line of business through such parts of our works as are open to public inspection.

Yours truly,

CORLISS STEAM ENGINE CO.,

WILLIAM B. SHERMAN, *Secretary.*

(Applause.)

RHODE ISLAND TOOL CO.,
PROVIDENCE, R. I.

*Mr. Eugene F. Phillips, American Electrical Works,
Providence, R. I.*

DEAR SIR: We are duly in receipt of your favor of the 23d instant, and note contents. We shall be very glad to have the electrical people visit our factory, and shall be happy to show them anything we have of interest.

Please extend to them our cordial invitation to visit us.

W. B. DART, *Treasurer.*

Here is a card signed by Eugene F. Phillips, President:

The pleasure of your company, with ladies, is requested at a house warming tendered to the members of the National Electric Light Association and their ladies on Thursday evening, February 19, 1891, at the new factory of the American Electrical Works, Stewart street, Providence, R. I. Grand march at 9 o'clock.

It is the intention that each member of the National Electric Light Association and their guests receive this invitation, and if, through error, they do not, the American Electrical Works would consider it a favor if they will apply to their representatives, P. C. Ackerman or W. A. Hathaway. (Applause.)

I have here an invitation from the American Institute of Electrical Engineers. As Mr. Pope, the secretary of the Institute, is present, I will ask him to read it for me.

MR. RALPH W. POPE: It is typewritten. (Applause.)

NEW YORK, February 14, 1891.

Allen R. Foote, Esq., Secretary National Electric Light Association.

DEAR SIR: The fifty-fourth meeting of the American Institute of Electrical Engineers will be held at the rooms of the Institute, No. 12 West Thirty-first street, New York city, Tuesday evening, February 24. A paper will be read by Mr. Oscar T. Crosby, of Boston, entitled "Date and Results of Experiments with Electric Traction at 120 Miles an Hour."

A working model of an electric railway made by Thomas Davenport in 1837 will also be exhibited in actual operation, and some interesting facts regarding its history will be given by Franklin L. Pope. Your Association and the Institute have many members in common, and for this reason the meeting has been postponed from its regular date, in order that those who desired might attend the Providence Convention without missing the meeting of the Institute. The Council extends to the members of the National Electric Light Association a cordial invitation to attend this meeting, and trusts that many of them may find it convenient to do so, in view of the fact that many will return home by way of New York, and also that the question of "Rapid Transit" will be discussed at the Electric Club, on Thursday of the same week.

Notices of the meeting will be distributed to your members in attendance at the Convention.

Yours very truly,

RALPH W. POPE, *Secretary.*

(Applause.)

I might say, in regard to the exhibition of that model, that about that time a model of Thomas Davenport's was exhibited in Boston, and it is very possible that the researches made by this Vermont blacksmith were among the reasons that led to the formation of the company in Rhode Island to which you refer. I think that the whole forms a very interesting fact in the historical progress of electricity.

Mr. Brown: Mr. President, it seems to me that it would be proper to make some acknowledgment of the courteous invitations that we have received which have been read by the Secretary. I, therefore, move you that the courteous invitations read by the Secretary be received and placed on file, and the Secretary of the Association be instructed to make suitable acknowledgment thereof.

The motion was carried.

THE PRESIDENT: The first order of business will be the Report of the Committee on Copper Tariff, Charles A. Brown, Chairman.

REPORT OF THE COMMITTEE ON COPPER TARIFF.

MR. BROWN: Mr. President, the Committee on Copper Tariff has practically no report to make. At the last Convention we reported the progress that we had made at that time. The reduction of the duty on copper was, as you all know, embodied in the McKinley Bill, which became a law, and there is now a very low rate of duty—something like twenty per cent. of the former rate of duty on copper in its various forms. This Bill having become a law, and this now being the duty on copper, and no further action being required at the hands of this committee, I would suggest that the committee be discharged.

MR. DE CAMP: I move that the report be accepted and the committee discharged.

The motion having been seconded, the question was duly carried.

MR. BROWN: If it is in order, I have a telegram here from Mr. J. P. Barrett, Chairman of the Bureau of Electricity of the World's Columbian Exhibition, expressing his sincere regret that he is unable to be present at the meeting of the National Electric Light Association. The serious illness of one of his children makes it necessary for him to remain in Chicago. He sends his best wishes for the success of this Convention and of the National Electric Light Association.

THE PRESIDENT: Gentlemen, you hear the communication; will you take any action?

MR. DE CAMP: I move that it be received and placed on file.

THE PRESIDENT: The motion is made that it be received and placed on file. Unless I hear some objection, that action will be taken.

THE PRESIDENT: The next order of business is "Electric Lighting as Applied to Steam Railroads," a paper by W. H. Markland.

Mr. Markland read the following paper:

ELECTRIC LIGHTING AS APPLIED TO STEAM RAILROADS.

Among the first to make use of the advantages afforded by electric lighting were the steam railroads, not as a means for lighting trains, but for lighting buildings, etc. In the year 1881, the Pennsylvania Railroad introduced its first electric lighting plant in a new shop in Altoona. That proved quite a success. It might also be mentioned that the same dynamo and lamps are in use to-day. In the year 1885, the Pennsylvania Railroad commenced lighting its depot shed in Altoona by arc light from its own dynamos, which proved a success as compared with the previous gas light, although it was crude compared with what the company now has.

The question then presented itself: Can freight yards be successfully lighted by electricity to reduce accidents, facilitate business and prevent breakage of cars and contents? The two latter items are quite a money consideration on any railroad. Some previous attempts had been made at lighting railroad yards by electricity, but without much success previous to the attempt in Altoona. I speak particularly of the Pennsylvania Railroad in Altoona, as I am very familiar with the lighting that has been done there, and also because what the Pennsylvania Railroad does is liable to be copied by other roads, and we sometimes get good ideas from other roads.

In Altoona, when drawing up the plan for lighting the yards, the question presented itself: How high and how near together shall the lights be placed? the problem of lighting the freight yard being more complicated than lighting a city, as in lighting a city lamps can generally be placed at street corners and quite low, the general public being not over-particular, so that under or near the lamp the light is quite brilliant, but in the space between the lamps there is less brilliancy.

For lighting where engineers and trainmen have to work, it is not the brilliant light that is wanted, but the evenly distributed light. If a light be too brilliant, trainmen when near lamps will be partially blinded, as we might call it, for a short time, as, in the event of their leaving a lighted space, it would be difficult for them to distinguish objects or signals and would lead to complaints.

In order to get an evenly distributed light, lamps at Altoona were placed on top of 65 foot poles, these being about eight feet in the ground and set so as to illuminate switches and crossovers where the yards were narrow. Where yards were wide and long, lamps were placed about 600 feet apart, a row on one side of the yard and a row in a broad alley that was wisely left between tracks near the opposite side of the yard, the light of the two rows being zigzagged to prevent shadows and to better diffuse the light. This plan of lighting does not make a brilliant light at any point, it being possible, but difficult, to read fine print. A light more like moonlight was the result, and proved very good in practice. Even a clear globe was objectionable, on account of the shadows of side arms. A lower half ground globe was preferable, it having been proved by experience that it was better to lose a little light than to have shadows.

One noticeable result followed the introduction of this light. It enabled the car inspectors to examine cars much more thoroughly, and, as you all know, perfect car inspection is very important. A decreased amount of pilferage also followed, as the watchmen were able to see persons at a great distance at night. The breakage of cars and their contents was but little, if any, greater at night than in day-time. I cannot say how much money was saved by the introduction of the electric light from pilferage and breakage of cars and contents, yet I believe it was really more than the cost of maintaining the lights.

Undoubtedly the introduction of the electric light has prevented accidents to employes; of course, I cannot say to what extent.

The electric lights are certainly a great help in shifting cars, as it enables the trainmen to see the tracks and position of switch points about as well at night as in the day-time, on account of the light shining on the top of the rails, they, being generally bright from passage over them, making a sort of reflector. Also, in coupling and dropping cars, it enables the brakemen to gauge the distance the cars are apart fully as well at night as in the day-time, so cars can be coupled without any more jar or danger than by daylight. It also assists in dropping or switching cars very fast, as is often necessary during a time of increased traffic. It enables the switchmen in the towers to tell when a car is over a switch, so that they can quickly throw the switches with less danger of throwing the cars off the track or on the wrong track.

A few words about the erection of arc lamps and poles for freight yards. Poles must be very well set in the ground and guyed so as not to sway from heavy rolling stock passing, or from wind. The poles, being high, receive the full benefit of the wind. A good, true chestnut pole for lamps, if possible to obtain, answers very well. They will cost when shaved, stepped and erected, with hood, about $35. The price will be governed largely by the cost of timber. Short poles must also be well put up so that there may be no breaks.

Railroad people are very exacting; it does not do to have any stops or shut-downs. The lamps must be kept in good order. Maintaining arc lamps near railroads is quite different from maintaining lamps in most stores. If there is a poorly insulated part in the lamp, the soot will soon find a path for the current across the poor insulation, and out goes your lamp. Your cut-out contacts will corrode very fast. When it comes to your rods, expect to have a lot of dirty ones. In a railroad yard there are things to contend with not common with most lighting, and that is smoke and steam. I have seen poles covered from one end to the other with a film of soot from engines. This, in getting on the hanger boards, is sure to make escapes unless the insulation be very good. The insulation should also be good to enable the inspector to work at a lamp in case of its failing to burn when the current is on.

Get a good reliable direct current double carbon arc lamp that is well insulated. A lamp that is heavy, bulky, or has liquids, is not well adapted for the purpose, on account of the difficulty of carrying it up the pole. Do not rely on the hooks of lamps for connection between the lamp and the hanger board, for they will corrode and cause trouble. It is better to always put a piece of flexible wire from the hanger board to the lamp to carry the current. Always use good insulated wire and good insulators when running up poles or side arms. It is better to splice on a piece of the very best insulated wire. Experience has proven that the wooden part of hanger boards is better for having some water-proof insulation between it and the side irons to prevent leaks.

I do not favor double-pole switches on hanger boards in freight yards, as they require extra contacts, the brass-work of which soon corrodes so as not to make good connections, and leads to trouble.

The dynamo should be self-regulating and easily kept in order. As there may be 100 lamps, taking, say, two dynamos for all lighting at one point, it is better to put a little more money into dynamos than to pay high wages to the dynamo tender.

Keep as far away from telegraph and telephone lines as possible. If any danger is done to either of the above, the railroad generally gets the worst of the suit.

If you are going to hire the lights from a central station, see that they give you good work, and make a contract with a rebate and fine for the time lights are out.

If you once properly put electric lights in a freight yard, you will never get them out again; the trainmen will not stand it, as they would be in the dark, in more senses than one, if the lights were taken away. But if the lights are not properly put in, say, on low poles, under 40 feet above ground, or not properly spaced, the chances are there will be complaints on account of too much light at some one point and too much darkness at some other point. Great care should be taken to place lamps so they will not interfere with signals. I have seen cases where electric lights were so placed that a signal could not be properly distinguished, on account of the electric light shining on the lenses and blending the colors. A case like this can generally be avoided by placing some arrangements so that the electric light will not shine on the signal.

The electric light is rather a help to distinguish the position of the semaphore arm, although trainmen at night look for the color of the lens rather than the position of the arm.

The electric light is something of a help in distinguishing the switch signals, on account of the light shining on the lenses. These being low, the light will rarely show through them.

If it comes to a question of moving an electric light or a signal, you will find that the electric light will have to go every time, as railroads will not allow any interference with signals.

If you go too high, you will not get the full benefit of the light, as has been proven where the tower system of lighting is in use.

In laying out freight yards, a broad alley, say, 12 feet between tracks, should be allowed for placing the lamp poles, where the yards are over 300 feet wide.

As to the other uses for electric lights for railroads, I do not know that there is much out of the regular run. The light is used quite extensively for lighting depot sheds, where it is more economical than gas and decidedly better. This class of installation requires the very best of work and insulation, as the smoke and steam nuisance enters here. Even though depot sheds are dry inside, porcelain knobs should not be used, glass with a double petticoat being the only kind now on the market that answers the requirements well, on account of the soot settling on the insulators.

It does not do to have a depot in darkness; for that reason a depot shed should be wired with two complete circuits, having every alternate lamp connected to one circuit and the remainder to the other. Then, in the event of a break in the wire, only one-half the lights are out.

Experience has proven that the arc light is much superior to the incandescent for depot shed lighting. With incandescent lights the necessary volume of light is costly to maintain, and, also, the globes of incandescent lamps soon become dirty from steam and smoke, which interferes with the light or, if cleaned off, necessitates considerable labor.

For freight transfer stations the arc light is very satisfactory. It enables the men to quickly distinguish marks on merchandise, and also enables the foremen to see what the men are doing, preventing loafing. One 2,000 nominal candle power arc lamp to about 1,500 square feet of floor space will generally light a transfer station where lamps can be zigzagged. Where transfer stations are narrow, more light per square foot should be allowed. On a platform about 10 feet wide, as they generally are, one light every 60 feet gives good illumination.

I doubt if the arc light can compete with gas for this purpose, as far as cost is concerned, taking transfer stations as they are, generally lighted by gas, and as they should be, lighted by arc lights. Yet, I believe, taking the amount saved in labor and from pilferage, that the electric lights more than pay for themselves.

Another point comes in here. We all know that on a wet, dark day we do not feel inclined to work as we do on a bright, sunny day. The same is the case at night; if you give men good light it brightens their spirits up and they will work much more cheerfully; and getting men cheerful means more work done.

For offices and shops the electric light is used considerably, much the same as for other places of like nature.

I hear that an electric headlight has lately been brought out, which, it is claimed, will illuminate a track for a mile or more. I am of the opinion that the light will not come into general use. In the first place, a light for this purpose should not be too strong, or it will blind an engineer coming in the opposite direction, this being a serious objection. Most of the roads east of the Ohio are not very straight, and the chances are that, while on curves, the neighboring cornfield will receive more light than the track ahead, as no one has invented a light that will show around the corner.

If any inventor wishes to get up an electric locomotive headlight let him confine himself to one of low candle power—the present ones are about 20 candle power. I do not think one of over 100 candle power will be in demand until railroads are illuminated from one end to the other by electric light, which will be the case in the future, and then the headlight will not be required.

These points are necessary for an electric headlight: First, and all important, reliability; second, simplicity. Economy you can leave out. If you can get 50 per cent. of what can be attained in a station, it will do. One thing must be borne in mind—engineers are not electricians. Thus, a dynamo lamp must be as simple as the air-brake, and no more liable to get out of order.

The experiment has been tried of lighting cars by electricity. While it has proven a success in some cases, as far as convenience is concerned, financially it has not proven a success. Electric lighting of trains is a luxury to-day, and will continue to be until some more economical plan is invented. The advance that is being made with the use of gas as an illuminant for cars, is leaving electricity behind. From the best information I can get, it costs 50 cents per hour to light a car by electricity from storage batteries, against five cents per hour from carbureted air.

The electric light is used to some extent by different railroads for lighting wrecks, or any construction work that requires night work. For this purpose the Pennsylvania Railroad and the Cumberland Valley road have a car fitted up with boiler, dynamo, engine, water tanks and coal bunker, and all the tools necessary for a central station. With a car of this description, quick work in getting lamps in place is all important. In one case, after the Johnstown flood, I, with the help of four men and the engineer, put up six arc lamps, put up the poles for the lamps, which were designed for the purpose and carried on the car, ran the wire, coupled up the lamps, and had the lamps going in 35 minutes from the time we, with the car, lamps, poles and wire, arrived on the ground. The lights were distributed some distance, one being about one-third of a mile away. I doubt if construction work was ever done quicker.

I will not go into a description of this car, as it was very ably explained by Mr. W. F. Taylor, of Altoona, at the Convention of Railroad Telegraph Superintendents, at Niagara Falls, June 19, 1890.

To give an idea of what the Pennsylvania Railroad Company thinks of the electric light, I might say that its new Juniata shops at Altoona, having about 100,000 square feet of floor space, are lighted entirely by the electric light; there is not a pipe for illuminating gas in any of the buildings. All the traveling cranes are run by electricity.

The Pennsylvania Railroad Company believes that good electric work pays. I doubt if any station, central or isolated, has more reliable or better designed appliances, or more artistic work than can be found at the Juniata shops of that company.

DISCUSSION.

Mr. De Camp: I remember six or seven years ago it was reported that the Pennsylvania Railroad Company had appropriated, if I may so put it, a certain amount of money to the experiment of lighting cars, which has been referred to in Mr. Markland's paper, not only electric lighting, but experimenting with various forms of lighting by gas and oil. I had some knowledge, at the time, of the use of the storage battery. The other methods of car lighting by electricity I know nothing about, and heard very little about it; but I presume they have come to some definite conclusion upon the subject. If the gentleman can tell us, or is at liberty to state, what are the precise conclusions of the railroad company as to the relative merits of electric lighting as compared with any other form, and particularly as to the different methods used in electric lighting, either by battery or by direct current from the dynamo, I think it would be very interesting and useful to the Association.

MR. MARKLAND: I may say that the question of lighting cars by electricity is somewhat out of my department, but I should say that six or eight years ago we tried experiments with the storage battery. We first had the storage battery under the cars. That was tried for a while, but not with much success. Then the railroad company made nine or ten cars for use between Jersey City and Philadelphia. They were all lighted with the storage battery. We had a certain amount of success. It was rather a difficult matter, though, as we had to charge the batteries at Jersey City, and it so happened that if we had rather a dark day and then had to run the cars back to Jersey City at night, the chances were we would have to come back with no light, which was, of course, not very pleasant. I think they equipped probably 15 or 20 cars with the storage battery under that plan, and they tried almost every kind of a storage battery without any great success. I might say, by the way, that we have thrown the batteries all away now, and have put in gas. The Pullman Limited, as you may all know, is lighted with a dynamo, which is located in the baggage car and connected with storage batteries in the cars, where they are charged from the dynamo. Of course, that does pretty fair; that is, they get very good light on that train. But when you come to figure up the cost you will find that is pretty heayy. About the time electricity came into use, however, several systems of lighting cars with gas were developed. The Frost system, I think, and several others, came into use, with which I suppose you are all familiar in Philadelphia. The old way for lighting with compressed illuminating gas cost us in the neighborhood of ten cents an hour, with six burners, but since we have got this Frost system (I think that is the name), why, the cost of lighting is so small that we can hardly find it; not over five cents an hour for seven burners, and they are, I should judge, of about 20 candle power.

MR. BURLEIGH: I was in hopes from the title of the paper that it was on incandescent lighting as applied to coaches; but I was particularly interested as a railroad officer in the paper, and especially in that part of it about the application of electricity to use around wrecks. We all appreciate the value of a good light around a big wreck in the night-time. But the most interesting thing to me in connection with the Pennsylvania Railroad experiments in electric lighting in our part of the country is that they have decided to buy their lights of our company, and not manufacture it themselves. (Laughter and applause.)

MR. FRANCISCO: I have been very much interested in Mr. Markland's paper, especially in reference to that part of it regarding the lighting of railroad cars. I have been furnishing light to the Central Vermont Railroad Company for the last two years, lighting the railroad yard, the station and the round house. His theory of the best plan is the same as that we have adopted there, by placing lights upon the tops of poles. Our poles are 50 feet above the ground, with lamps on top of them. In the round house we find very serious trouble; in the old style of round house, with a dome at the top and a platform in the center to transfer the engines to different tracks. Of course, our lamp hangs in the center, and every engine that comes in stops on that platform and opens her pipe and throws the dust and soot and everything up where it settles on the lamp. Naturally, it covers not only the lamp, but the whole top of the building, so that in many cases you will find the dirt an inch deep. We have trouble in getting short circuits on the lamp, from that stuff gathering and making one solid block on the lamp. Now, if Mr. Markland has any suggestions that he can give to correct that, we should be very glad to know how it can be done. This top is covered with soot, smoke and cinders, which, all combined, makes a regular paste. In the stations we use the arc lights, suspended from different parts of the station. We have had a great deal of trouble protecting the lights from being short circuited.

Mr. Markland's remarks in regard to railroading and railroad electricity as applied to cars, reminds me of a little incident that came under my observation as I was passing down the Missouri Pacific road. I wanted to stop off at Omaha, and I left the steam cars at a junction which connects with the electric road to carry passengers into the city of Omaha. While standing there waiting for the electric car to come up, an Irishman and his wife walked up and stood a moment and asked me if the horse car did not go over to Omaha. I said: "Yes, it is coming now." He looked down the line and saw the car coming. It was an electric car. He turned to his wife and said: "Bridget, d'ye mind, they've got the horses behind." Pretty soon the car came up, and we got on the rear of the car, and the Irishman turned to his wife and explained: "Bridget, be jabers, there are no horses behind." He sat a few moments quiet, and then turned to me and said: "Sir, can you tell me what it is that is drawing this car?" I said, "This is a new-fangled thing that they have got up, going all over the country. It is a hobby that the Aldermen of the present time are advocating. They go to work and buy cars and get what they call a plant, and put them in, and start these cars on the road, and they run themselves. There is no expense to the city whatever, after they get going." Just then the motor made a considerable sort of rumbling, and the Irishman turned to his wife and said: "Bridget, d'ye mind, the Divil is dragging this car; just listen to him groaning." (Laughter.)

This principle of applying electricity to the lighting of cars and to the motive power of cars, is one great point. People at the present time do not seem to understand it; they can't understand electricity. It seems to be a sealed book to almost the entire mass of the people. And there is where the trouble at the present time lies in our advancing the cause of electricity and the way we have to meet it.

Mr. Pope: It is one of the arguments against electricity always that it is dangerous, and one of the reasons why it has been adopted for car lighting (although it has been expensive) is because it was safe. In going out on the Jersey Central road the other day I saw a Pullman car with half a dozen of the windows boarded up on the outside. The next morning I read in the newspapers: "Gas explodes under a car. Two men severely injured in the New Jersey Central yard." I do not know that such an accident is usual, but they are now introducing the gas system on the New Jersey Central Railroad, and the plant which they set up cost them $75,000. Why this accident occurred has not yet been ascertained, but I presume it was not due to electricity, because there are no wires in the cars. (Laughter.)

Mr. Markland: Do you say that was on the New Jersey Central Railroad?

Mr. Pope: Yes, sir.

Mr. Markland: What manner of lighting do they use there?

Mr. Pope: I think it was the Pintsch gas system; but these cars were Pullman cars.

Mr. Markland: That is something new to me. I had heard of no trouble from the use of gas.

The President: I think we are all agreed, gentlemen, that gas is dangerous and obnoxious. (Laughter.)

Mr. De Camp: As I take it, there is no question of the desirability of electric lights on the part of railroad companies, but it is simply a question of cost. I also take it, in the spirit of progress, the railroad companies weigh very carefully the relative value of it. It is not that it lessens the cost in one case ten cents an hour and gas costs five cents. They don't stop with that fact, but they stop after having duly considered whether it is worth that difference; the safety of it and the comfort of it being given due consideration.

I think, if the matter could be got into the public mind, that electricity is not of no cost—that is, a sort of free boom to those who are manipulating it—for instance, Mr. Francisco states that it is almost impossible to educate the people up to that fact. We, as central station men, are all bothered with the idea on the part of our municipal authorities, and on the part of private consumers, that we are exacting from them an enormous price. My experience has been that the time spent in trying to explain away those matters and convince the public that this element of electricity does cost money to make it, is wasted. But when corporations like the railroad companies, who are working for their own interests and are not trying to make money outside, or to profit from anything from the community, put themselves on record as stating the fact in the case, that they cannot afford to use the electric light solely on the ground that it is expensive, I think it will make more impression on the community as to the real cost of the article in which we are dealing than anything else we may say in the matter. Therefore, I take it, when you get down to the pith of it, the Pennsylvania Railroad Company, and all other corporations, would certainly give electric lighting the preference, at least at the same cost of any other illumination.

MR. MARKLAND: I have no doubt of that.

MR. DECAMP: So much, I think, can be put down to the credit of electricity.

MR. MARKLAND: I might say, although I prepared this paper, that I do not speak for the railroad company at all. It is only my own observation from what I have seen.

THE PRESIDENT: If there are no other remarks I will close the discussion.

ANNOUNCEMENTS.

THE PRESIDENT: I wish to say that all members of the Association in attendance on the Convention are heartily welcomed to the Narragansett Station. The presence of your badge is all that will be necessary to secure your access to all of the departments. We have been something of a pioneer in this field, in constructing and designing a large station, and very likely have made some mistakes, and must pay for our experience, as all pioneers have to.

The Exhibition is almost opposite the Narragansett Hotel on Broad street, not more than one or two hundred feet. The Hall is open to-day; that is, they are getting everything in readiness, but it will be duly opened at seven o'clock this evening; the formal exercises will take place about eight o'clock.

On account of the large number of important papers and reports to be presented, and also on account of the memorial session, the Executive Committee have decided to extend the meeting so as to include two sessions on Friday, making a four days' meeting.

If there is no other business, a motion to adjourn until three o'clock will be in order; and I desire to say to you that I hope every gentleman will be prompt in attendance.

On motion, the Convention adjourned until three P. M.

SECOND SESSION.

Called to Order at 3.15 p. m.

The President: First on the order of business is the Report of the Committee on Underground Conduits and Conductors; C. H. Wilmerding, Chairman. As Mr. Wilmerding has not been able to attend the Convention, and in the absence of the Secretary, I will read the report myself.

REPORT OF THE COMMITTEE ON UNDERGROUND CONDUITS AND CONDUCTORS.

The Committee on Underground Conductors begs to submit the following report for the last half year. The change which was made recently in the Chairmanship of this Committee delayed, to a great extent, any active work on its part. The further delay in getting our printed matter, which it was intended to send to all companies operating underground conductors, has left us without any information on the subject in hand. It was proposed to follow out the lines indicated in the report of the Committee at the Twelfth Convention. Only one company has reported, viz., the Chicago Arc Light and Power Co., which reports as follows:

Miles of duct occupied by high tension underground conductors	28½
Miles of lead covered cable in ducts	79
Miles of cable in iron pipe or bracketed under sidewalks for distribution	72
Total number of miles of underground high tension cable	151
Total number of cases of trouble on underground cable, 1890	31

Divided as follows :

Result of mechanical injury	18
Result of defective joints	4
Result of defective insulation	2
Other burn-outs, cause not accurately determined	7

During the year 1890, 33.8 miles of underground conductors were laid by this company, and during that period there was one case of trouble on this 33.8 miles, the trouble being in a defective joint. They further report that their rebates during the year for defective service amounted to one-third of one per cent. of the gross earnings; and they estimate that possibly one-third of these rebates are attributed to circuit trouble; the balance to defective lamps, dynamo and engine trouble and miscellaneous causes.

The longest underground circuit is 7½ miles from pole to pole, and carries an electromotive force of 2,500 volts. They add that blizzards have not in any way affected their service.

The Committee, in offering this report, realizes that the information is of a very meagre character, but is of the opinion that if similar reports, or still fuller reports, could be had from all companies operating underground conductors, very interesting and instructive data could be laid before the Association, and they request that when questions are published and sent to various companies, they will receive attention, and that the information required will be given fully and cheerfully by all those whom the circulars may reach.

DR. MASON: I move you that this report be accepted and the Committee discharged.

The motion was carried.

THE PRESIDENT: The report of the Committee on Relations between Manufacturing and Central Station Companies will be presented by Mr. Weeks.

MR. WEEKS read the following report:

REPORT OF COMMITTEE ON RELATIONS BETWEEN MANUFACTURING AND CENTRAL STATION COMPANIES.

The functions of this committee are almost defined by its title. The idea of, and the necessity for, this committee is to have a recognized counsel for mutual conference and conciliation in case either a manufacturing or a central station company should feel aggrieved by the business methods of those with whom they may have dealings, or be called upon to contend in business competition. In cases of this kind, the committee can take no action unless requested so to do by one of the aggrieved parties. No such appeal has been made to the committee.

This committee is also intended to represent the general interests of central station companies in case of unwarrantable competition in cutting prices for public lighting contracts, or to secure franchise rights in a town where a company is already in active operation and ready to perform all forms of service required at reasonable rates. Your committee is glad to state that no case of this kind has been brought to its notice since the Twelfth Convention. It has, therefore, not been called upon to use the influence of the Association in this direction.

It is thought advisable to continue the committee as one of the standing committees of the Association. The time may come again, as it has certainly existed in the past, when it will be necessary for this committee to exercise functions such as those indicated, or conduct negotiations of a different character under instructions from the Association.

MR. ARMSTRONG: I move that the report be received and the recommendations adopted.

DISCUSSION.

MR. DE CAMP: That is all right so far as it goes, but it seems to be a sort of stereotyped action on the part of the Association, and, as the chairman has stated, the object sought to be gained by this committee is an exceedingly difficult thing to get at, even when you have a case in point to base your actions upon. I have no suggestions to make as to a line of action to be taken either in a case stated or in any other case. But the same thing has gone on right straight along, all the time, and the manufacturing companies, with a great deal of affability, find a way of avoiding it. I have had occasion within the last year of seeing the operations of just those movements on the part of the manufacturing companies. The case that I have in my mind is the case in which the Thomson-Houston people are the parties who are really the aggressors in the matter. They say, well, of course, the Thomson-Houston people have nothing at all to do with the Fort Wayne. We, of course, understand that the same people are interested in it. Now, they have a territory where they observe strictly their agreements with the parties who have bought the rights to their apparatus and do nothing. They sit passively by, but they are hissing on the other fellows with all their might and main. That case was stated—the case of Campbell, which I was talking about last year. The same thing has happened in Philadelphia in the last six months. Now, there is one thing that has come to my knowledge of late which I am not prepared to say anything definite about, because I have not an answer to a letter I wrote on the subject, in the case of the manufacturing Brush Company, who originally sold its franchises to several companies in the East and West under a guarantee to protect them in their patents; that is, they were only able to make those deals by stating that they had fundamental patents which would protect the company paying them their royalty, or whatever you may call it, in the use of the property. It has never been worth one farthing to the company that has paid for it. A notable case of the evil effects of that has been in New Orleans, where the original company that bought its right from the manufacturing company in Cleveland has been absolutely wiped out, and they have been wiped out because of the competition that has come in there, encouraged by the very people that started them, and they have brought suit—all of which has been noticed by you gentlemen, perhaps—in a very large amount, and, as far as I understand their contract with the manufacturing company, I think it is precisely the same as the Philadelphia contract. You can just imagine how vigorously the Brush Company in Cleveland is going to prosecute those suits against that particular lamp because it is owned by the Thomson-Houston people. I do not imagine that they are going to push that thing very hard. I do not know what reply I will get from the attorneys in New Orleans to my letter, but my idea now is this: That if the claims of that company, and others who are alike situated, are not recognized by the Cleveland Company, and they will not prosecute those suits in the spirit in which their contract was made, it will be a very good thing for the people who are now affected, and who are likely to be affected, to join in that suit with the New Orleans people and make a very vigorous fight on it. And, further, that if we cannot gain a point in that way, why, take it as they have put it. They have laid claim, I think, for $300,000 damages. Now, I think some movement of that kind by the members of the Association would have a very good effect; much better than going direct to these companies; I have never got any satisfaction out of that.

THE PRESIDENT: If there are no further remarks, the discussion will be closed. Those in favor of the motion that the recommendation of the committee be adopted as read, the report received and placed on file and the committee continued, will vote aye.

The motion was carried.

THE PRESIDENT: The next matter of business is a paper by H. F. Prentiss, on "Distribution of Steam from a Central Station." Mr. Prentiss is not present, and the paper will be read by Judge Armstrong.

MR. ARMSTRONG: Mr. President and Gentlemen: I have not read this paper, but I have glanced at it and find that one-third of it is made up by reference to diagrams that are not here and diagrams that I would not undertake to produce. I find there are references to percentages that I can understand, and, as I go over it, I will do the best I can to give the results of all these various diagrams and calculations. I may, however, stumble considerably in it. If I do, don't blame the paper, but when it is printed the diagrams will accompany it, and I suppose you will all completely understand it.

DISTRIBUTION OF STEAM FROM CENTRAL STATIONS.

What has the distribution of steam from a central station to do with electric lighting? This question can be answered much after the Yankee fashion of asking another. What have coal-tar, ammonia, analine dyes to do with making gas? These articles are by-products in the manufacture, which were once thrown away as useless, but which have now a value hardly second to that of the gas itself. Is it not true that the exhaust steam of electric light engines as a by-product in the making of light, and for heating purposes, has a value scarcely, less than the electric light itself? Since in a steam engine the amount of heat converted into work is relatively small, the value of the by-product or the exhaust steam is too large to suffer neglect. It is only a question of finding a market for it, and, obviously, this can only be done by a system of distribution from a central station. Will it pay to market this by-product? The answer to this question depends upon many complications and varied circumstances which in no two plants would be found alike.

The history of commercial electric lighting covers hardly a decade. The same is true of the sale of steam from underground pipes radiating from a central station. In both these enterprises, frequent failures have been met with and many lessons learnt. I believe it is a fact, however, that all present existing steam companies more than pay expenses. A few have paid dividends, while many have been obliged to re-invest their earnings in improvements, or in remedying defects in original construction. The very few absolute failures have been due to faulty design, or defective engineering at the start. In the city of New York, two companies were started less that ten years ago, one of which, owing to faulty design, failed and gave up business; the other, known as the New York Steam Company, is supplying steam for power and heating to nearly 700 consumers, and sell the product annually of more than 100,000 tons of coal, burned under boilers aggregating nearly 20,000 horse power.

In its distribution of steam through underground pipes the company has had many obstacles to contend with, the chief trouble having been the securing of absolutely tight joints. This difficulty has been completely removed by the method employed during the last four or five years, as is well attested by the network of pipes on Madison avenue, and the adjoining streets, between

Fifty-third and Seventieth streets, where nearly three miles of pipe are in perfect operating condition and practically without a leak. The engineering difficulties, which, in an enterprise of this kind, would strike one as more difficult to provide for, namely, the expansion of the pipe and the losses due to radiation, were more perfectly provided for at the start, and, therefore, with the improvements which have been attained through practical experience of nearly 10 years, the system has been brought to a state of perfection where, in new work, but little more can be desired. The pioneer work has been done and the electric lighting companies are, therefore, in a position to reap the advantage of the experience gained and to begin their work where the steam companies have left off, and can, therefore, feel certain in seeking for a market for their by-product (their exhaust steam) to meet with no mechanical difficulties of construction.

The joining of two enterprises together, such as electric lighting and the distribution of steam from central stations, has both its advantages and its defects, and we must weigh one against the other. The electric light station is already in possession of its boiler house equipment, and for this reason has much less to charge up to the construction expense of steam distribution than a steam company, since its boilers are available for supplying steam directly to the street mains when light is not called for, or when the engine load is at a minimum, and can, furthermore, by proper adaptation, deliver the exhaust steam from the engine into the street mains, and, for the purpose of heating, recover the larger portion of the original heat value of the steam. Again, in a combined plant, the general expenses of management, superintendence, and so forth, need not greatly exceed the cost for the same items in a single plant alone. An obvious disadvantage is the increased back pressure put upon the engines. I am assuming, of course, that the engines are of a non-condensing type. The prejudicial effect of this back pressure is a subject which will repay a little study.

Thirty pounds of water per horse power per hour is the recognized standard of boiler capacity, and is also a fair statement of the amount used by an engine of fair size exhausting into atmosphere. A portion of the work of such an engine is spent in overcoming the atmospheric pressure of 15 pounds per square inch, and when, therefore, in addition to the pressure of the atmosphere, an increase of back pressure is incurred, the useful work of such an engine is diminished by a corresponding amount. If this increase of back pressure is only that required for circulation of the steam for heating purposes, the increased consumption per useful horse power per hour will not be greatly augmented in consequence, provided the pipes are sufficiently large and properly run.

The heating of residences by steam supplied from our Fifty-eighth street station, is often effected with steam at a pressure of one or two pounds. And it is well known that there are several systems in use where exhaust steam is applied for heating in a manner so as to make it possible to produce a vacuum in the heating coils. The back pressure of the exhaust, therefore, in a system where the engines discharge into street distributing mains, depends almost solely upon the size of the mains and the quantity of steam carried. A loss of pressure of 10 pounds in a half-mile of pipe provides a carrying capacity reasonably in accordance with the cost of the pipe. Of course, if this difference of pressure exceeds 10 pounds the cost of transportation becomes relatively less, while the loss at the engine becomes greater, and *vice versa*, in case the loss of head producing flow of steam is less than 10 pounds. This, like many other details, must be determined upon in each particular case. In order to illustrate this point, I will present some calculations based upon a back pressure of 17 pounds, absolute (about 2.3 pounds ordinary gauge), with an initial pressure of 92 pounds absolute (or about 77.3 pounds ordinary gauge pressure). We will call this Case No. 1.

For Case No. 2 let us take the back pressure at 30 pounds absolute (about 15.3 gauge), and the initial pressure at 105 pounds absolute (or about 90.3 pounds ordinary gauge).

In Case No. 3 let the back pressure be 105 pounds absolute, and initial pressure 180 pounds absolute. The last case is interesting, since it called for a theoretical consumption of steam per indicated horse power in an engine with an initial gauge pressure of about 165 pounds, and a back pressure of about 90 pounds gauge. The diagram marked *A* shows the cycle of changes of steam used under the above conditions—omitting the practical considerations of wire-drawing, compression, early release, and so forth, which are the interesting characteristics of an indicated diagram. The tremendous amount of unutilized work, due to the excessive back pressure, is clearly shown by the area of the rectangle P_2 V_2. In this diagram P_1 and P_2 are laid off as ordinates to represent the initial back pressure, while V_1 and V_2 are laid off as abscissæ to represent the volume of one pound of steam before and after expansion. The expansion curve *m n* is supposed to follow the law $P V^{\frac{17}{16}} =$ constant. The diagrams *B* and *C* represent Cases 2 and 1.

At pressure P_1 (180 pounds absolute), Fig. A, the volume V_1 of one pound of saturated steam is 2.49 cubic feet, and at pressure P_2 (105 pounds absolute), the volume

V_2 of one pound of saturated steam is 4.14 cubic feet. Neglecting all cylinder losses due to condensation, leakage, clearances, etc., and supposing the expansion curve to conform to the formula $P\ V^{\frac{17}{16}} = $ constant, we have for the total work in foot pounds of one pound of steam, $P_1\ V_1 \text{ x } 16\ (P_1\ V_1 - P_2\ V_2) = 95{,}645$ foot pounds. Deducting the work of overcoming the back pressure $(P_2\ V_2 = 62{,}597)$, we obtain $(95{,}645 - 62{,}597) = 33{,}048$ indicated foot pounds, and as 1,980,000 foot pounds per hour is equivalent to one horse power, it is evident that an engine working under conditions above named would require $\frac{1{,}980{,}000}{33{,}048} = 60$ pounds of water per horse power per hour.

In a similar manner it may be shown that between the limits of pressure 90 pounds (105 pounds absolute), and 15 pounds (30 pounds absolute), there would be required 26 pounds per indicated horse power hour. This covers the case of an engine exhausting into low pressure street mains.

An engine exhausting into the atmosphere with two pounds back pressure (17 pounds absolute), and receiving steam at 77 pounds (92 pounds absolute), would require 19.7 pounds of water per horse power per hour.

In actual practice the losses due to clearance, wire drawing, incomplete expansion, cylinder condensation, etc., would have to be added to the amounts above given.

If in the last case (*C*) we add 10 pounds, making about 30 pounds per horse power per hour, we shall have an average practical result as obtained from automatic single cylinder engines of fair size.

The great loss due to cylinder condensation is largely dependent upon the difference of temperature between that of the steam at admission and that at exhaust. In cases *A*, *B* and *C*, this difference is, respectively, 42 degrees, 81 degrees and 102 degrees, and hence with the same size cylinders in each case, it is quite sufficient to make the same allowance of not more than 10 pounds additional for *B* and *C*, making for *B* about 37 pounds per horse power per hour, and for *C* 70 pounds per horse power per hour.

Now, in an engine operated in such a manner, there would be, during expansion, a loss of heat due to conversion of the internal energy of the steam into work amounting to $\frac{16\ (P_1\ V_1 - P_2\ V_2)}{772} = \frac{31,104}{772} = 40.3$ thermal units per pound of steam, which would produce a condensation amounting to 3.3 per cent. The total thermal units (above 32 degrees Fahrenheit) per pound of steam at 105 pounds (absolute) pressure is 1,182.4, or (1,182.4 — 181) = 1,001.4 above the temperature of the feed water (212 degrees Fahrenheit). Hence, the available heat in the exhaust would be 1,001.1 x .987 = 968.35.

Before entering the cylinder, however, the steam at 180 pounds (absolute) contained (1,195 — 181) = 1,014 thermal units per pound above the temperature (212 degrees Fahrenheit) of the feed water. Hence the total loss due to conversion of heat into work is $1 - \frac{968.35}{1,014} = .045$ = 4½ per cent.

In addition to this loss in the cylinder of the engine, we must consider a further loss at the boilers, owing to the fact that by raising the pressure we have the temperature of the steam, 42 degrees.

Now, assuming that the increase of the temperature of the escaping gases amounts to 42 degrees (and it certainly can be no greater), and allowing 24 pounds of air per pound of coal, we have 42 x 24 x .238 = 240 thermal units lost per pound of coal burned.

Now, assuming that one pound of coal evaporates at 105 pounds pressure (absolute) 8 pounds of water, which is equal to (1,182.4 — 181) x 8 = 8,011 thermal units. The loss at the boilers, therefore, may amount to $\frac{240}{8{,}011}$ = about three per cent. Adding this to the previous loss of 4½ per cent., we obtain a total loss of 7.5 per cent. But this loss must be figured on a basis of 70 pounds of water per horse power per hour, and hence, when computed at 30 pounds, becomes $7.5 \times \frac{70}{30} = 17.5$ per cent.

Therefore, we have practically obtained our work in the high pressure electric light engines at the rate of five and a quarter pounds per indicated horse power per hour, the re-evaporation during exhaust, together with the unbalanced motion of the steam eddies, wire drawing, etc., appearing again as steam or useful heat in the street mains.

This is clearly an extreme case, but for this reason it better serves as an illustration. The percentage of steam condensed to water through the conversion of heat into work during expansion, would be greater in Cases 1 and 2, but in these cases it would hardly be necessary to consider any possible extra loss at the boiler.

Diagram *D* is the representation of an indicator card taken from an engine operating under conditions of excessive back pressure similar to Case No. 3, diagram *A*. The back pressure in this instance was about 55 pounds above atmosphere, and the initial pressure about 130. The engine was an automatic cut-off type taken from the salesroom of a well-known engine builder, having been built for ordinary duty and not especially designed or altered for work of this unusual character. The engine was directly belted to a 750 light A. C. Westinghouse dynamo, which supplied current to about 600 incandescent lamps in the Lenox Lyceum, Fifty-ninth street and Madison avenue. The building was wired throughout on the Edison three wire plan, and the converters were arranged two in series, with a middle wire to suit these conditions. The plant was supplied with electric meters and the various station instruments, and represented, therefore, on a small scale, a central electric lighting station. The exhaust pipe of this engine was directly connected with our street mains, where an average steam pressure of about 55 pounds was always maintained. The steam from the street mains was used in part for operating elevators in apartment houses, and for running engines, and in part for heating. If we follow the steam in its course through the electric light engine, thence through the elevator, engines and pumps, and other engines along the line of the underground steam mains, and thence to the radiators, where condensation takes place, it will be evident that an economy is attained similar to that in a compound condensing engine, the electric light engines playing the part of the high pressure cylinder, the other engines playing the part of the low pressure cylinder, and the radiators taking the place of the condenser.

This engine was operated under these conditions three or four evenings a week for about a year, affording a perfectly steady and satisfactory light from the incandescent lamps. The running of the engine was not attended with any special difficulties, and gave no more care and occasioned no more trouble than if exhausting into atmosphere. On several occasions the exhaust of the engine was shut off from the street mains and turned into atmosphere, the initial pressure being reduced at the same time to correspond. At other times the reverse of this change was effected, and the exhaust turned from the atmosphere into the street mains, without in either case producing a noteworthy fluctuation in the light from the incandescent lamps.

The gross revenue to be derived from the sale of steam for the heating of buildings may be estimated at from $2.50 to $5.00 per 1,000 cubic feet of space heated per season. The amount of heating to be obtained per mile of street mains will evidently vary very much, according to locality, and in the dozen or more district steam companies it is interesting to note what this variation is. In the smaller towns, where systems of underground steam distribution exist, the space heated seems to vary from 1,000,000 to 2,000,000 cubic feet per mile of street main, and in the case of a larger city reaches 5,000,000, and in the city of New York exceeds 15,000,000.

The cost of plant (which in these figures includes boiler house and boilers) varies from $20,000 to $30,000 per mile, and in one instance reaches $50,000.

In New York city the cost very much exceeds these figures, owing in part to the difficulties encountered and in part to the fact that the street mains were laid with a view to supplying steam for power. In the New York plant the pressure of steam in street mains is above 80 pounds, and furnishes a supply to over 500 engines, and requires for this purpose in the summer time about 250 tons of coal daily, and, including heating, reaches 500 tons daily in the winter. The cost of a district steam plant where the business is confined to heating alone seems to vary from $10.00 to $20.00 per 1,000 cubic feet of space heated. Here again this cost includes boiler house and boilers.

In order to make it clear beyond dispute that the business of a district steam company can be added to that of an electric lighting company, without prejudice to the latter, two points only need be established. First, the possibility of utilizing the exhaust of electric light engines, without detriment to the light and without introducing any serious complications or expense in the management of the station; second, the certainty of an extra revenue, the net profits of which will equal or exceed the profits from the lighting plant for equal amounts of money invested. I have already touched upon both of these points and need, I think, only refer to the practical working of the combined system at the Fifty-eighth street station of the New York Steam Company, where the back pressure of the engine was 55 pounds (with no inconvenience, and with no extra expense, save an almost indeterminate increased consumption of fuel), to prove that, with a back pressure of only 15 pounds, a practical mechanical success is assured. Of course, to get the same power from the engines it would be necessary, unless previously running with a light load, to increase the initial pressure 15 pounds, or to the same extent that the back pressure is increased. The effect of this, as I have shown, will be merely to pass a little more steam through the engine per horse power, which ordinarily would be bad practice and a waste of fuel, but, when distributed and sold for heating purposes, has nearly the value of live steam taken direct from the boiler. There would be times, of course, when the demand for heating would be slight, and when, therefore, it would be more economical to use a free exhaust, or, where there were several engines, to have only a portion of them deliver their exhaust into the street mains. The experiments of the New York Steam Company, previously cited, showed that the engines could easily be shifted from one exhaust pressure to the other without detriment to the light, and, therefore, be easily possible to secure at all times a maximum of economy which a combined system would permit.

So far as profits and dividends are concerned, a very considerable saving would follow by the mere union of the two interests, without even taking into account the values of the exhaust steam. Since, however, so much is dependent upon local conditions, it is impossible to give figures which would apply to anything more than a hypothetical case. The amount of heat lost by radiation from the pipes of the New York Steam Company showed the loss to be about three per cent. of the carrying capacity of the pipes. It may be well to add here, as having a most important bearing on the profitableness of such an investment, some of the details of the cost of underground steam work. The sizes of pipe most common in practice are those having diameters of four inches, eight inches, and ten inches, the carrying capacities of which, with steam flowing with an initial head of 15 pounds, are, respectively, about 50 horse power, 150 horse power and 600 horse power. The cost of the underground construction, which includes valves and the special appliances, such as variators, service box, anchorages, insulation, etc., may be roughly estimated at $7.50 per foot for the ten inch, $6.00 for the eight inch, $4.50 for the six inch, and $3.50 for the four inch. In many instances, where large buildings adjoin the lighting station, many of the appliances may be omitted, and much of the expense spared which must usually be counted in the cost of long distance work.

The average price received for steam from the aggregate of consumers, large and small, is somewhat more than double the cost of producing the steam at the boiler house. This average is one willingly paid by the consumer, owing to the saving in cost of labor, and to the many conveniences and advantages to be derived from having steam on tap like gas and water. Out of these gross earnings, which exceed 50 per cent. of the receipts, there must be subtracted the cost of maintaining the street system, leaving a balance applicable either for dividends, improvements or new constructions, or, as often is the case in new enterprises, this balance must be expended in reconstruction made necessary through defects arising from lack of experience at the start.

The entire annual gross receipts of a plant are, of course, limited by the carrying capacity of the pipes, and may be estimated at about 40 per cent. of the cost of construction, and, therefore, net earnings of 25 per cent. will permit of 10 per cent. dividends. Since the cost of steam amounts to 50 per cent. of gross receipts, it is evident that if one-half of the steam sold for heating can be obtained from engine exhaust, the saving effected in this way alone will amount to enough to pay 10 per cent. dividends.

In this paper I have attempted to show the complete practical and commercial feasibility of combining a system of steam distribution from a central station with an electric light station plant in a manner to utilize the exhaust.

I have given data that will assist in investigating the value of the plan in any locality where heating by steam could be introduced, but have purposely omitted to give any description or details of mechanical appliances and construction of underground steam work, as it seemed to me that the more important issue for discussion was the question—What has the distribution of steam from a central station to do with electric lighting?

THE PRESIDENT: The Chair will call on Mr. R. H. Bishop to open the discussion.

DISCUSSION.

MR. BISHOP: Mr. President and Gentlemen: In responding to this invitation, to discuss the paper just read upon the subject of steam distribution from central stations, I would state at once there is little to be said except to confirm the statements therein made. Of course, I shall not go over the technical arguments showing the theoretical reasons why the distribution of steam is mechanically possible. The fact that it has been successfully done for more than 12 years, and that there are now more than 30 different cities, besides the expensive plant in New York, with which Mr. Prentiss is connected, show that it is a developed industry. At the same time, it may be said that the combination proposed, the use of exhaust steam from electric plants, is of a few years development only, for the reason that electrical plants themselves are of very modern origin.

The especial subject before you now is the practicability of electrical and steam combinations. Your attention has been especially called to the utilization of exhaust steam from your engine, and the natural inquiry is as to its effect upon your engines and boilers through back pressure. The author of the paper just presented has shown that there is no theoretical reason why this cannot be done, and supplements his reasoning with reports of his own practical experience, and to those I am pleased to add reports of others' experience. The American District Steam Company constructed a short line of street mains in the fall of 1889, for the Edison Electric Light Company in Kansas City. Mr. E. R. Weeks, the efficient manager of the company, is here, and I would prefer that he would answer the questions connected with this subject as referring to that plant. In the fall of the same year the Ottumwa (Iowa) Railway, Electric and Steam Company, in addition to extensive street railway and electric lighting plants, had over two miles of street mains constructed, in connection with their other interests. The president of the company has kindly furnished me with some data referring to this subject that I am sure will interest you, as the several figures will answer many questions that I apprehend will arise in your minds. The exhaust from the engine connects directly from the street mains, which mains are also connected with the steam drums over the boiler. By means of reducing valves, it is under the control of the manager in charge, to add live steam in any proportion required to the supply of exhaust, or to use none at all. They have two engines; one in connection with the street railway, which runs, from 6 A. M. to 11 P. M., the light engine and dynamos during the hours required. They now have 69 buildings taking steam at various points along the line—some quite large, such as the Post Office, Opera House, school buildings, churches, business blocks, residences, etc. The exhaust steam from the railroad engines supplies nearly all the steam required to maintain pressure in the two miles of mains to supply heat to the 69 buildings. Part of the time a small amount of live steam is added. When the light engine is in use also, the present consumption does not use all of the exhaust. The pressure at the boiler house, in the street mains, is 12 to 15 pounds. The pressure indicated 1,000 feet therefrom is one to two pounds less; the pressure indicated 4,300 feet therefrom is three to six pounds less than at the boiler. These figures were taken when all the buildings were taking their quota of steam, and still there is a large margin above what is required for the present consumption. At this date they have about 15 per cent. of the probable future consumption. Another equal amount is in sight now for the coming year. Application has been made already for that increased consumption. The present earnings are, net, about 13 per cent. upon the cost of this feature of their enterprise, with another equal amount in sight, as I before stated, in the coming year, which will involve no increase of expense, excepting for fuel.

In answer to my inquiry as to what the apparent effect of the engines and boilers was, he says nothing, except that 12 to 15 pounds of extra pressure must be carried.

Another illustration of this use of exhaust steam can be quoted from the Springfield Electric Company, and I am glad to see the president of that company here. This pipe was laid last fall. The President informed me last week that it worked perfectly. They deliver the steam through nearly 2,000 feet of mains at two and three pounds back pressure. They are so pleased with this saving of exhaust steam that they propose an extension of the mains the coming season.

Another similar undertaking was made by the Duluth Company last fall. I had not seen them to obtain details. There is another plant at Chester, Pa.

Thus far, we have viewed this exhaust steam as a by-product—that is, purely as referring to electric light plants. But may we not hereafter refer to it as the original commodity. You buy real estate, erect building and boilers, lay railroad tracks, equip with motors and cars, buy coal and water, employ a force of men; yet, it is all a useless aggregation until you fire up the boilers. By combustion of fuel, and absorption of the heat units by water, we load this water with the fuel value of our product, and do you utilize all by former methods? This is your important question. I believe it is conceded that the average engine makes use of only about 10 per cent. of the heat absorbed. The balance has heretofore made its escape. Like the compound engine to which Mr. Prentiss makes comparison, we propose to exact further duties from this power, which we can, if we turn it into the street mains and heat our buildings as well as light them, so that when the water becomes water again it has contributed its full value of heat absorbed to the investment.

You naturally ask, about how much value has this steam? An approximate answer may be given by stating that each hundred horse power of boilers steaming at 20 or 25 pounds pressure has a capacity for heating 1,500,000 cubic feet of space. This is the maximum. The minimum figure, allowing for all absorption of heat by engines, is 1,000,000 cubic feet for each 100 horse power.

Since reaching the city I have had the pleasure of asking Mr. Ide, of Springfield, the amount of their heat. He does their heating now upon nearly 1,000,000 cubic feet of space, and using but little to exceed one-half of 100 horse power boiler; so that would fully sustain me in these figures.

Mr. Prentiss has already told you this is worth, according to the price of fuel, $2,500 to $5,000 per 100 horse power for the season. You can form an approximate idea of how much steam you are throwing away. The figures obtained from plants in operation indicate that the extra expense incurred to accomplish this does not exceed 25 per cent. of the income even now. Of course, all of this is accomplished only by constructing mains in the most approved manner.

Another important question in connection with this general subject is that the earnings from electric light plants is confined from six to eight hours out of each 24. The balance of the time the boilers and men are comparatively idle. Instead, then, of banking your fire from 16 to 18 hours, waiting for the time to come to commence earning again, keep all steadily at work at low pressure supplying heat. It costs but little more to run the boilers, engines and other machinery lying still, at 15 or 20 pounds, than to bank the fires and hold them at the higher pressure without use. The heaviest load in heating is during the hours that the electric work is lightest.

The whole subject is finally reduced to this suggestion: Add the steam heating to your other industries, that you may get all that is possible out of your plant by working 24, instead of six or eight hours, and especially to get out of your steam all the value that it contains, instead of being satisfied with a small percentage only. These are the fundamental principles of success in any business.

Is it not apparent that this subject has something to do with electric lighting?

THE PRESIDENT: The Chair will call on Mr. Weeks to make some remarks on the subject.

MR. WEEKS: I would rather not occupy the time of the Convention on this matter, as long as we have those who know so much more about it. At present we have Mr. Ide, of the Springfield Company, to whom Mr. Bishop has referred. I would prefer rather to hear from him first.

THE PRESIDENT: If Mr. Ide is here, we would be glad to hear from him.

MR. IDE: My experience in heating has not been very long or extensive. Last fall we put in about 2,000 feet of main, about one-third eight inch, the balance six inch. Our station is favorably located in the central business portion, and we conceived the idea of selling our exhaust steam. We have a five year contract for furnishing power for an electric railway. At present they are running 10 cars. We also run a motor circuit that is now using about 50 horse power. We made a contract with seven store buildings to heat them for five years with exhaust steam at a price averaging about $200 a year. The buildings contain about 100,000 cubic feet of space each. We did not contract for any more at that time, because we wanted to be sure to have sufficient exhaust steam to supply them. We have now given about four months' service, which have been very satisfactory in every respect, warming the buildings satisfactorily in the coldest weather. We have never exceeded four pounds back pressure. Ordinarily we carry two pounds back pressure, and the gauge shows a reduction of about one pound at the extreme end of the mains. We estimate that the expense of furnishing this exhaust steam is trifling. We do not notice any difference in the consumption of coal required, and we now find that with the surface exhaust steam we do not utilize over half. Next summer we expect to add about a thousand feet more main. We think our present steam will be sufficient to double our capacity. We estimate that the receipts we get from steam are about one-half profit. It does not require any additional attendance. It is simply the interest on the investment on the plant, and the slight additional fuel it requires.

MR. POPE: In connection with this subject, it is interesting to note that it is a reversal of the proposition that was made by the New York Steam Company some six or seven years ago, to utilize their waste steam at night for electric lighting—I think in connection with the Parker system. I never heard anything more about it, excepting that it was a newspaper statement, in which they gave interviews with steam heating people and some others as to the practicability of it. Since that time I have heard nothing of it at all.

MR. SEELY: I would like to ask whether, in utilizing this exhaust steam, the exhaust is confined to a boiler or cylinder before it is forced out into the main; also whether the mains are enclosed in any special jacket, to prevent the steam from escaping, or expansion of joints of any kind—whether they have had any trouble whatever?

MR. BISHOP: The connection is made direct with the exhaust pipe—no drum, simply a continuation of the street main.

Your second question, in regard to the method of construction. There is a very elaborate system of covering for protection against condensation, and a provision made for expansion and contraction of iron. It is known as the Holley system. The drawings I can show you at any time. This point is only attained by having accomplished those two points—not losing our steam by condensation, and being able to control the iron under expansion and contraction. I say it is known as the Holley system, which I shall be glad, whenever you wish to see it, to show to you.

A MEMBER: How deep do you have to lay your pipes?

MR. BISHOP: They do not have to be laid any depth. That is controlled by the existing conditions of the street, to get out of the way of gas, or the water and such mains. To illustrate—a plant that we built in Syracuse was located on the north side of the canal, and the work was on the south side, and the pipe was carried over an iron bridge. So we can suspend it in the air or bury it, just as the conditions offer.

MR. WEEKS: I do not know that I can add very much to what has been said. I consider the matter of the distribution of the heat from a central station a very important question, and one that I think the near future has a solution of in store for us. I have hoped, and still hope that the solution will be an electrical one. But so long as the best electrical heaters require from 300 to 400 watts 15 minutes, about 90 watt hours, to boil a cup of tea, we cannot hope for very satisfactory results in the balance sheet by using that system. It occurred to us in Kansas City that we were having, as Mr. Bishop called it, a by-product which we might possibly get something out of. We, therefore, contracted with the Holley company to put in a few hundred feet of pipe in connection with our station which is located in the business center of the city, and arranged with our neighbors in the immediate vicinity within the block, to do their heating for them. We have found that we have never carried over six pounds back pressure, and from that it ranges down to two; it usually runs about three or three and a half pounds. We have had the plant in operation now for 15 or 16 months, and have been very much pleased with its operation so far. We have cleared about 50 per cent. of the cost of that plant to us during the first year, and I think that we can considerably increase that net result by adding other customers.

THE PRESIDENT: The next paper on the list, on the "Municipal Control of Electric Railroads," by Morris W. Mead, has not been presented. The next after that is the report of the Committee on National Insurance Rules; George Cutter, Chairman.

MR. FRANCISCO: The Committee has accomplished nothing and it has consequently nothing to say. I move that the Committee be discharged.

The motion was carried.

MR. FRANCISCO: I move that the President appoint a Standing Committee to formulate Wiring Rules and Insurance Rules.

THE PRESIDENT: I had suggested in the morning that I had a recommendation prepared, which is right in the same line; and, with your permission, I will present it:

RECOMMENDATION BY THE PRESIDENT.

"I recommend that a Standing Committee be appointed to formulate and, from time to time, revise a code of instruction to be known and published as Instructions by the National Electric Light Association for the safe and economical wiring of streets and buildings for the service of electric light and power, and for the proper inspection and maintenance of the same."

MR. FRANCISCO: I will accept that as a substitute for my motion.

MR. BROWN: As the seconder of the motion, I will second that.

THE PRESIDENT: Are you in favor of the adoption, or will you have it referred to a Committee?

MR. DE CAMP: I move its adoption.

MR. BROWN: I second its adoption.

THE PRESIDENT: All in favor of the adoption of the recommendation just read as the action of this body, will say "aye." (Adopted.)

MR. DE CAMP: Do I understand as the sense of that resolution that the Chair will appoint that Committee?

THE PRESIDENT: It is within the province of the Convention to say how the Committee shall be appointed. I simply suggest that such a Committee be appointed. The resolution simply provides for a Committee; the manner of appointing the Committee lies with the Convention.

MR. FRANCISCO: My intention was that the Chair should appoint that Committee.

THE PRESIDENT: Then a motion to that end would be in order.

MR. FRANCISCO: I move, then, that the Chair appoint that Committee.

MR. BROWN: I second that motion.

MR. ARMSTRONG: Isn't that already provided for, that under our rules the Chair is to appoint all committees not otherwise provided for?

THE PRESIDENT: That may be, but the shortest way to settle it is to put the motion. All in favor of the motion will say "aye." (Carried.)

THE PRESIDENT: That concludes the body of the business for this afternoon. There was a long paper down on the programme, which, of course, would have consumed the time, but the paper is not here; and, if there is no other business to come before the Association, a motion to adjourn would be in order.

Before that motion is made, however, I desire to state that the members of the Executive Committee are requested to meet in the Secretary's room at once.

MR. BROWN: I move that we now adjourn.

MR. BURLEIGH: I second the motion.

MR. DE CAMP: What time do we meet to-morrow morning?

THE PRESIDENT: At 10 o'clock. Now, all in favor of the motion that we now adjourn until to-morrow morning at 10 o'clock, will say "aye."

The motion was carried.

The Convention then adjourned until Wednesday, February 18, 1891, at 10 A. M.

EXPOSITION.

Open from 9 A. M. until 6 P. M. Open from 7 P. M. until 11 P. M.

THE EXHIBIT.

In connection with the Thirteenth Convention of the National Electric Light Association, an exhibition of electrical apparatus and appliances was held, especially such as are used in the business of furnishing light and power.

A suitable hall was secured opposite the Narragansett Hotel, which was the Association Headquarters, and, through the courtesy of the Narragansett Electric Lighting Company, all the electric current necessary was provided. There were run into the hall three circuits, viz.: 1st, an incandescent alternating current converted to 50 volts; 2nd, a 500 volt direct current; 3rd, an arc current of 6.8 amperes.

On Tuesday the exhibition was informally opened at 9 A. M. and closed at 5.30 P. M. It was opened again at 7 P. M., and formal opening exercises took place at 8 P. M.

On Wednesday and Thursday the exhibition was open from 9 A. M. until 6 P. M., and from 7 to 11 P. M.

The exhibits were in three departments, known as Morrison Hall, Duncan Gallery, Weeks' Hall.

The exhibitors were as follows:

N. Y. Insulated Wire Co., New York city, insulated wire and cables.

Phœnix Glass Co., N. Y. city, electric glassware, globes, etc.

Washburn & Moen Mfg. Co., Worcester, Mass., samples of wire.

Electric Engineering and Supply Co., Syracuse, N. Y., electric lighting and railway supplies.

Swartz & Gannett, Providence, R. I., electric appliances, accumulators, phonographs, etc.

The Eddy Electric Motor Co., Windsor, Conn., motors and dynamos.

Jewell Belting Co., Hartford, Conn., belting.

American Electrical Works, Providence, R. I., insulated wires.

Jenney Electric Motor Co., Indianapolis, Ind., motors and switches.

Interior Conduit and Insulation Co., N. Y. city, interior and underground conduits.

James W. Queen & Co., Philadelphia, Pa., electrical instruments.

Drake, Payson & Whittier, Providence, R. I., electric models, motors and specialties.

The Okonite Co., N. Y. city, insulated wire, etc.

The E. S. Greeley & Co., N. Y. city, electrical instruments and supplies.

Electrician Publishing Co., Chicago, Ill., headquarters *Western Electrician.*

Alexander, Barney & Chapin, N. Y. city, general electrical supplies.

H. T. Paiste, Philadelphia, Pa., switches, cut-outs, etc.

The Bryant Electric Co., Bridgeport, Conn., electrical supplies.

Bernstein Electric Co., Boston, Mass., series lamps and instruments.

T. M. Foote Regulator Co., Boston, Mass., speed regulator.

The Holtzer-Cabot Electric Co., Boston, Mass., electric light appliances.

John Lynch, Washington, D. C., terra cotta conduits.

The C. McIntire Co., Newark, N. J., McIntire connectors, etc.

Eureka Tempered Copper Co., North East, Pa., copper brushes, commutators, etc.

Standard Electric Supply Co., Boston, Mass., voltmeters, ammeters.

Narragansett Electric Supply Co., Providence, R. I., display of incandescent lamps, etc.

The Johns-Pratt Co., Hartford, Conn., vulcabeston insulation.

Shultz Belting Co., St. Louis, Mo., belting.

The Walker Electric Co., N. Y. city, ammeters, voltmeters, etc.

Electric Power Publishing Co., N. Y. city, magazine.

The *Electrical Engineer*, N. Y. city, magazine.

Modern Light and Heat, Boston, Mass., newspaper.

Chas. A. Schieren & Co., N. Y. city, belting.

Sperry Electric Light Co., Chicago, Ill., arc lamps, etc.

Thomson-Houston Electric Co., Boston, Mass., recording watt meters.

G. G. Stillman, Boston, Mass., Spencer damper regulator.

Electrical Supply Co., Chicago, Ill., electrical supplies.

Safety Insulated Wire Co., N. Y. city, wire and cables.

Russel Electric Co., Boston, Mass., arc lamps.

Simplex Electric Co., Boston, Mass., insulated wire, etc.

Great Western Electric Supply Co., Chicago, Ill., electrical supplies.

New England Butt Co., Providence, R. I., braiding machines, etc.

Star Electrix Co., Philadelphia, Pa., switches, sockets, etc.

Fairbanks-Brown Co., Boston, Mass., supplies.

AN EXHIBIT COSTING $600,000.

In addition to the varied exhibits made by manufacturers, the entire plant of the Narragansett Electric Lighting Company, that has cost $600,000, was an exhibit of the best engineering practice of the day.

ORDER OF BUSINESS.

WEDNESDAY, February 18, 1891.

THIRD SESSION, 10 A. M.

Memorial session in honor of the pioneers of electrical industries.

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Hello!   Hello!!   Hello!!!

LIGHT AND POWER.

FOURTH SESSION, 3 P. M.

1. Paper, "The Electric Arc and its Use in Lighting."
   By Prof. Elihu Thomson.
2. Report. Committee on the Proper Classification of the Lighting Power and Incandescent Lamps.
   Dr. Louis Bell, *Chairman.*
3. Report. Committee on Legislation.
   Hon. E. A. Armstrong, *Chairman.*

THIRD SESSION.

WEDNESDAY, February 18, 1891.

The Convention was called to order by the President at 11.10 A. M.

THE PRESIDENT: It seems eminently proper that we should pause a moment in our advancing course, like a traveler ascending a mountain side, to look back upon the path he has already traversed. There will be many things of interest, and many things to remember that are gay, and some that are sad, for they are not all with us who started out in the morning of our work.

There are those here who represent the ocean cable and the overland telegraph and telephone, that which has enabled two continents to converse together, the inhabitants to hold familiar intercourse with each other. Those who witnessed the first division of the electric current and saw the glow of the infant incandescent lamp. Those who witnessed the first uncertain sputter and flare of the arc lamp in its early state. Those who by their energy and perseverance have dotted the country all over with the little stars of the incandescent or vacuum lamp, and the sun-like brilliancy of the arc light, until they vie with the firmament above us.

The transmission of this mysterious energy by the hundreds of horse power over a little conductor no longer than our grandmother's knitting needle to revolve the wheels of our industrial establishments and propel in all directions vehicles for the transportation of passengers and freight.

These are only a few of the triumphs which have attended the development of the industry which we represent, but it is not my desire to entrench upon the time which belongs to you. I wish, however, to relate a single instance of my experience. One of the first duties which came to me as manager of the Narragansett Electric Lighting Company was the laying out of a new circuit.

When I first came into the Narragansett Company, six years ago, Mr. Thomas had just been appointed superintendent, and the first duty we had was to lay out a new circuit within two or three days after we came together. He was somewhat new to the business, and I myself but little acquainted with it, and we thought we would draw it out on paper, and we looked down this street and back again into this building and out again, and it was a very crooked affair, and I said, "Thomas, this will never do. We know electricity is not going around those corners; it is going to fly right off the angle of the wire straight to the ground and go into the buildings." He said, "No; when I was working for the burglar alarm system we used to coil the wire on a pencil, and I think the idea was to give it a whirling motion so that it would go around these corners." So we put out the circuit crooked and it has worked ever since.

I will request Judge Armstrong to read some letters we have from some of our distinguished guests who have been unable to be present.

Judge Armstrong read the following letters :

LETTERS FROM INVITED GUESTS.

EXECUTIVE OFFICE, WESTERN UNION TELEGRAPH CO.
NORVIN GREEN, *President.*

NEW YORK, February 17, 1891.

Hon. M. J. Perry, President ; Allen R. Foote, Esq., Secretary.

Dear Sirs : Thanking you for your kind invitation to become the guest of the National Electric Light Association, at your First Decennial Celebration of Electric Lighting, and the Thirteenth Convention of your Association, to be held in Providence, R. I., Feburary 17, 18 and 19, I sincerely regret to find it impossible for me to attend. My condition of health would render the journey hazardous, and the exacting nature of my official duties would scarcely admit of my absence, whilst the general manager is also absent from illness.

The genius of modern invention, and especially in the line of the application of electric science to commercial and domestic uses, has marked the present age as an epoch in the World's history. During my lifetime more progress has been made in the advancement of commerce and manufactures, and in the annihilation of time and space, than had been made in 10 previous centuries. Lightning had been drawn from the clouds or generated by friction and batteries, and bottled up in Leyden jars. But it was an untamed horse and nobody knew of any useful purpose it could be applied to. But modern inventions have harnessed it to the wires and sent it flying overland and under water through all quarters of the earth, making instantaneous communications with the most distant points. More recently it has been made to glow in lamps with a brilliancy and softness of light far transcending in utility and convenience anything ever before known, both for streets and public halls, parks and private buildings. Still more recently it has been harnessed up for power, and the street railways are smoothly and swiftly running over the surface without any visible traction.

No conception or foresight can define to what other and further uses this wonderful element may be applied. All we know is that new and improved discoveries and devices are constantly being made, and the men engaged in it are winning a fame and recognition of which their descendants will have just reason to be proud.

I am, my dear sirs,

Most respectfully yours,

NORVIN GREEN.

NEW YORK, February 9, 1891.

Messrs. Marsden J. Perry, President; Allen R. Foote, Secretary, National Electric Light Association.

GENTLEMEN: I regret that a previous engagement deprives me of the pleasure of accepting the polite invitation of the National Electric Light Association, to attend their meetings at Providence, R. I., on the 17th, 18th and 19th instant.

I remain, gentlemen,

Yours very faithfully,

CYRUS W. FIELD.

COMMERCIAL CABLE COMPANY.—MACKAY-BENNETT CABLES.

JOHN W. MACKAY, *President.*
HECTOR DE CASTRO, *Vice-President.*
GEO. G. WARD, *Secy. and Gen. Mgr.*

EXECUTIVE OFFICES,
WASHINGTON BUILDING, 1 BROADWAY,

NEW YORK, February 16, 1891.

Allen R. Foote, Secretary, National Electric Light Association, 18 Cortlandt Street.

DEAR SIR: Your esteemed favor of the 13th instant was duly received, and I beg to express my appreciation of the high honor tendered to me by the invitation to attend the sessions of the Convention of the National Electric Light Association, to represent the subject of Ocean Telegraphy.

I delayed acknowledging the receipt of your letter until now in the hope that I might be able to avail myself of the privilege of being present at the Memorial Session, on Wednesday next, but the pressure of my engagements forbids my doing so; I am, therefore, reluctantly compelled to deny myself the pleasure, which I much regret.

Wishing you a very successful meeting, and thanking you for the souvenir you were kind enough to enclose, I remain,

Yours very truly,

GEO. G. WARD.

1336 NINETEENTH STREET,

WASHINGTON, D. C., Feb. 13, 1891.

A. R. Foote, 18 Cortlandt Street, New York.

DEAR SIR: I regret exceedingly that important business in Washington will render it impossible for me to be in Providence on the 19th instant, to meet the Electric Light Association.

Yours truly,

ALEXANDER GRAHAM BELL.

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956 EUCLID AVENUE.

Mr. Charles F. Brush regrets that important engagements will prevent his becoming the guest of the National Electric Light Association on the occasion of the first decennial celebration of electric lighting.

PRESIDENT'S OFFICE, MASSACHUSETTS INSTITUTE
OF TECHNOLOGY.

BOSTON, February 10, 1891.

Allen R. Foote, Esq., Secretary, National Electric Light Association.

DEAR SIR: I am very sorry to find that my duties on the 18th and 19th inst., will not allow me to leave Boston to attend the very interesting session at Providence, in celebration of 10 years' progress in electric lighting.

Yours truly,

FRANCIS A. WALKER.

THE PRESIDENT: Gentlemen, it gives me great pleasure to introduce to you one of the veterans of electrical service, Mr. Thomas Lockwood, of the American Bell Telephone Company, who will speak to you of the telegraph and the telephone. (Applause.)

THE TELEGRAPH AND THE TELEPHONE.

MR. LOCKWOOD: Mr. President, Ladies and Gentlemen:

It seems to me in order at the outset of my remarks that I should offer what the newspapers call "a word of personal explanation." I never have been fond of following fashions, or I think I should have written a letter. (Laughter.) I did not know until my arrival here that Dr. Norvin Green had not been able to appear. I knew that Professor Bell had been unavoidably detained in Washington.

We have it on no less authority than the immortal Shakespeare, that "Imperial Cæsar, dead, and turned to clay, may stop a hole to keep the wind away." This quality, I apprehend, is the only one which Cæsar and I share; that is the only parallel between us.

I do not feel able to respond for the telegraph in the way that Dr. Norvin Green could have done; I certainly cannot speak as authoritatively upon the telephone as the man who made it could have done; but so far as I can fill the places of either I will try so to do, even though the judgment of my audience at the conclusion of my remarks shall be that I have simply rustled around in their places.

The telegraph of to-day is about 55 years old. Prior to that there were numerous conceptions, numerous imaginative notions, but nothing practical. Almost from the earliest years of the Christian era, or, at all events, dating far back in the middle ages, there has been a conception prevailing among the literary portion of mankind, of what I may call the imaginative telegraph. This appears first in a Latin book written by Monk, and the conception, briefly stated, is that of two needles, poised upon pivots, and pointing to the periphery of a circle around which there were depicted the letters of the alphabet. It was said that if these two needles, which were of iron, were rubbed upon the same loadstone, that two friends might then take them and travel in opposite directions, and, at stated times, if wishing to communicate with each other, that by one of them pointing the needle to the various letters of the alphabet, the needle in the hands of the other would promptly respond and point to the same letters, and by that means conversation between the friends could be readily carried on.

This, I believe, was the first imagination of what has since proved a grand reality—the dial telegraph. It has formed the subject of story and song. Joseph Addison speaks of it in his essays, and our old friend Gallileo, who, although an ardent philosopher and a great scientist, was also a keen man of business, and who tells us in one of his stories that a certain man came to him and offered to sell him such a thing, and he said, "I do not care to buy it until I have first tried it, to see whether it will work." The person then declined to put it to a test and Gallileo said to him, "I do not care to go into the innermost parts of Muscovy simply to try an invention which I know will not work," and he asked him to sit down with him on a sofa and see if it would work, because he knew if it would not work for a short distance, it would not work for a long one.

As years rolled on electricity came to the front, and it was seen the only way by which intelligence could be sent for long distances was through its agency. Before the right plan came to the front several hundred wrong plans naturally came there. But, had it not been for the invention in the beginning of this century of the voltaic pile, I do not think we would have seen the electric telegraph, because that was the early beginning of electro-magnetic induction, and if we had not had the pile we certainly would not have had the dynamo.

But after that, in 1819, another real advance was made, another advance which magnetic applications of all kinds, and to which voltaic electricity owes its industrial application, were made. This was the discovery, in 1819, by the Danish Professor Erstedt, of the missing link between electricity and magnetism. I do not hazard anything when I say that to that one discovery everything that we now do by electricity is due, except, perhaps, what I think are the neglected arts of electroplating and electrotyping; since, as early as 1832, at least, our own Professor Morse, whom some of us have seen, and whom all of us have heard of, conceived, when he saw and witnessed the operation of electro-magnets, that the electro-magnet was the means through which electrical communication was to be devised. He came, he saw, but he did not conquer for at least five years from that time. In 1837 his first model was made, which, by 1842, was put into practice. The early line, as many of us know, was from Washington to Baltimore. The first message, which was sent by the daughter of Commissioner of Patents Ellsworth, was: "What hath God wrought." From that line nearly every line in foreign countries has proceeded. In this country we are apt to state that Morse is the inventor of the telegraph. We should say that he was the inventor of the electro-magnetic telegraph.

From those small beginnings what has arisen? This country is covered with lines from side to side, and from one end to the other. The entire civilized world is covered with electric wire. The continents are linked by under-water cable. To-day the business man conducts his business by electricity.

I would have liked that the ancient chronologist, the great sage of telegraphy to-day, the man who stood by Morse in his earlier years (and who is now in Scotland), Mr. J. J. Reed, were here. (Applause.) His name was brought to my memory by the incident which your President has related of the electrician who persisted in winding his wire around a pencil to overcome certain defects. I was reminded by that of the great faith which some of the early superintendents had in Reed. It appears that Reed had always been accustomed to roll up his record at the end of directors' meetings, but one eventful meeting Reed was absent. A Mr. Swayne presided over that meeting, and at the close of the meeting the Secretary *pro tem.*, proceeded to fold up his records, when Swayne grasped him by the arm and said: "Stop! Reed never does that; Reed always rolls them" (laughter), and the records were rolled.

It is very difficult for me, Mr. President and gentlemen, to speak at length upon this subject; but I would not do you or myself justice were I not to mention for a moment one or two of the later inventions which have made the telegraph what it is. If I should neglect to speak of the various methods of multiplex telegraphy, of the duplex telegraphy, originated, I think, in the first place by Dr. Gentil, of Germany, persevered in, and at last perfected and made a practical agent of civilization, by our own J. B. Sears, a Boston man, I should feel that I had neglected my duty. Just about six months before Sears did make it practical, one of the ablest electrical historians of Great Britain wrote a very capable, able and intelligent text-book of electricity as applied to the telegraph. The first part was composed of history, the second part of descriptions of apparatus; but one of the most remarkable things in that book, and one of the statements which will make that book immortal, is this: After describing the various methods, he said: "But all these things are simply series of electrical gymnastics, but which will never come to any practical account." Six months after that the duplex was working on the lines of the Franklin Telegraph Company in the United States, and making that company a formidable rival of the Western Union.

A very little while after that, it was seen that if it were possible to send two messages in the same direction over the same wire, if it were possible as it had proved to send two messages in opposite directions, it might then be possible, as a third stage, to put the two together and make a quadruplex. This was demonstrated by Oliver Heavyside, in England, and was put in practice by Mr. Edison and Mr. Prescott, on the Western Union lines. I need not undertake a description of the duplex and the quadruplex in this presence. If I should undertake it without apparatus and diagrams I should fail most lamentably and should doubtless tangle myself up in my own wires.

I must, however, mention that there is still one other direction in which telegraphy has spread still, in multiple telegraphing. But, discarding the ordinary duplex and quadruplex method, it was seen that the Morse telegraph, the manual operation of the Morse key, took up a great deal more time than was necessary, and that a wire was capable of sending a great many signals in a given unit of time, more than the individual arm was capable of sending upon it; and one or two men argue from that, that if this be so we may cut up the ends of our wire into 4, 8, 12, 16 different branches, and each branch would have possession of the entire main line for its individual moment, and, as the operator on such branch could send up to a certain rate, if we did not have a larger number of branches than the aggregate number of pulsations which all the operators were capable of sending, it might be possible in that way to send a large number of messages in either direction upon the same wire. The great difficulty was that it was not easy to make the moving ends of the main line at the two terminal stations move synchronously with each other; they had a habit of running one a little faster and the other a little slower, and very soon the two operators were working with people with whom they had no concern. And so the great point for the inventor there was to keep the main lines in synchronism. This was practically done by a man who had grown up as a telegraph operator, Mr. Patrick B. Delany. Providence is the place where, of all others, I should speak of this, because for a long time the practical line upon those principles was operated between Providence and Boston.

The British government has, as you know, control of its telegraph system. They like to stick to old ways over there perhaps more than we do in America, and yet that conservative government has seen fit to purchase the Delany invention, and I saw it in operation last Summer, when six messages were being sent over one line; and the British government is satisfied with it, and it is doing excellent work there side by side with the Wheatstone automatic.

I am quite certain that I have not failed in holding out to my first view as to my ability to fill the shoes of Dr. Norvin Green. I do not feel that I have done justice to the telegraph. I am, however, a little more at home upon the next branch of my subject—the telephone. Sir David Brewster, one of the greatest scientific men of a scientific age, and who died about 24 years ago, was a Scotchman, who for many years was at the head of scientific circles in England. More than once he was president of the British Association. He wrote a book some time between 1830 and 1840 entitled, "Letters on Natural Magic," and he closes a chapter devoted to automatic talking machines by saying: "We have no doubt that before another century is completed a talking and a singing machine will be numbered among the conquests of science."

That book is most interesting, and was published in 1832. It is not an easy book to get, but I had reason to believe that I would discover there what I did discover, namely, a chapter on talking machines. It is at least 200 years since talking machines have been in experimental use—I mean automatic concerns, which, when the operator performs certain operations, pressing a button here and a button there, would cause the machines to utter certain words, usually of a very low order, something like the words uttered by the phonograph dolls; and if you knew what those machines were going to say it sounded wonderfully like. (Laughter.) They could say "Papa" and "Mamma," and usually their vocabulary ended there. Whatever words those machines were constructed to make, those words they could make, and the mechanism was of a most complicated character, because their makers assumed that to copy vocal articulation they must necessarily copy the entire human mechanism, including the mouth, the larynx, the windpipe and so forth. I have often wondered that some time in reality someone has not tried to do what Frankenstein tried in story to do, and make an entire human being. You know he did construct a human being, but he couldn't make it the right size because he could not work on a sufficiently small scale, and when he got it built it was such a terrible thing that it frightened him and became the grief of his life.

Justice Sprague, one of the great lights of the legal profession, gave utterance to the following statements: "Prophecy after the event is easy prophecy." But this was prophecy before the event and is realized. Sir David Brewster's prophecy was not after the event, and it was not easy, but it was made by a man of science through the faith that was in him, generated from what he had seen and from what he knew of scientific laws. At the time when Mr. Brewster spoke, certain automatic machines had from time to time been made, which, laboriously imitating in their construction the human vocal organs, were able to repeat one or two words; but the machine which realized his prophecy employs as its talking organ simply a little disc of metal.

In the telephone, a double problem was solved, which was: (1) How to make a metal plate copy the motions of all complex organs of speech; and (2) how to make that one plate talk by electricity when that electricity was applied at a distance. In other words, if the person should be talking here, how shall he make an iron plate copy his talk somewhere else and reproduce it. There was one man of all the world, fitted by education to do it, and that was Alexander Graham Bell, because his father had from the earliest infancy of the younger man been a professor of visible speech. His profession was to teach dumb people to talk, and the younger man followed in his father's profession; and it was that profession which led him to teach a dumb girl in Cambridge to talk; and it was that profession which led him into the way to make iron plates talk, which was, as Sir Wm. Thomson puts it into classical language later on, that if we could make anything talk at a distance, if we would transmit speech, electrically, we have to realize "the mathematical conception that if electricity is to convey all the delicacies of quality which distinguished articulate speech, the strength of its current must vary continuously, and as nearly as may be in simple proportion to the velocity of a particle of air engaged in constituting the sounds."

That was the underlying discovery which made the telephone a reality, just as the invention of the condensation of steam by Watt made the steam engine a reality.

Prior to 1876 we had not many industrial applications of electricity. Probably 80 per cent. of the persons interested in it were engaged in telegraphy, and the remaining 20 per cent. was divided between instructors of youth and persons engaged in electrotyping and electroplating. I think we should do all honor to the men who, largely by rule of thumb, it is true, carried on some of the grandest uses of electricity from almost the invention of the voltaic pile in 1800 until the present time, without knowing much about it, without any literature on the subject, with only five text books up to the present time which touch upon it all, and yet who made that business a success.

All that is changed. The civilized world glows with the illumination of electricity; the electro-motor is abroad doing our work, and the long suffering car horse and mule are at last encouraged by the application of power to street railroads to believe that the day spring has visited them; while 500,000 telephones in the United States, and as many more in other countries, attest the fact that people will and must talk.

Those of you who know anything about the deeds

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which sometimes may go on in rooms like this—those of you who know anything of capitular masonry, will agree with me when I say "this is a good work." (Applause.)

But I wish to say more. I wish to say that all of this work which has been done is attributable to two things—a quality and a practice, enterprise and experimentation. There is no lack of the former in the United States, but I fear that we do not as yet fully appreciate the latter. It is impossible that I or any one can ever over-estimate the value of experiments.

Those of you who have studied the story of electricity and its triumphs well know how it was experiment that guided Orsted to the missing link between electricity and magnetism, which enabled Faraday to patiently fish out bit by bit the pieces of the puzzle composing the one department of electricity, which more than all others has made electrical illumination, traction and oral communication living realities—magneto-electric induction.

It was experiment that enabled Spencer, Jordan and Jacobi almost simultaneously to discover the art of electrotyping; and the Elkingtons with their associates about the same time to introduce electroplating; arts which useful from their inception have now become ornamental also, and which have put into the hands of true artists a ready means of reproducing the beautiful in a surpassingly beautiful way. It was experiment that carried Bell to the invention of the art and apparatus of telephony; and Thomson to the art of electric metal working.

And looking at the other side of the case, it is equallly certain that it is the neglect of experiment (which is our means of conversing with nature, asking questions of her and receiving her replies), and the neglect of reasoning based on experiment, which prevented electricity from advancing a single inch for the first 2,000 years of its history, from the time of Thales, the Ionic philosopher to the time of Gilbert the Elizabethan sage; the founder of electricity as a science.

We have heard it said that speech is silvern and that silence is golden; and the recorded opinion of that great and ancient patron of mormonism and masonry, King Solomon, is, "that a word fitly spoken is like apples of gold in pictures of silver;" so we see that even on the subject of speech there is room for two opinions, but that the telephone was, and is an immensely valuable adjunct to the American style of doing business, in which time is held to be a commodity of great value, none can doubt.

It is now used over lines of lengths varying from a few yards to several hundred miles, and as a labor saving machine, has proved its right to exist.

Whether it will ever be available for long submarine cable work, the future only can tell. All the indications of the case are that it will not; but who can limit the possibilities of the future after having seen so many apparent impossibilities achieved.

Such a possibility was contemplated even before the telephone itself had appeared.

On December 29, 1868, at a banquet tendered to Professor Morse, the British Minister, then Edward Thornton, Esq., in responding to a National toast made this remarkable utterance: "Should I have the good fortune to live to the age of the venerable Professor, I still hope to see some such improvement as will enable us to carry on a *viva voce* conversation by means of the cable. We shall then have merchants on this side of the water discussing their affairs with those on the other side at so much a minute. We shall hear, perchance, of some love-stricken youth of London or Paris whispering soft nothings along the cable to a bewitching siren of New York or Providence at so much an hour, she tempting him (Leander like) to throw himself into the gulf which separates them. We shall then have a statesman, and in these days of progress, possibly stateswoman, discussing international questions at so much a conference, and diplomatists will run a very good chance of being exploded altogether."

I have always wondered that somebody has not set Sir Edward up as an anticipatory inventor of the telephone.

We find in Holy Writ that when the prophet stood on Mt. Sinai the manifestations of the proximity of the Divine Presence were, successively, a strong wind, a fire, and a still, small voice, and I rejoice to-day that the still, small voice has been found worthy of being asked to take part side by side with the fire and the earthquake and the hurricane. (Applause.)

THE PRESIDENT: I have the honor to introduce to you one with whose fame and whose works you are all acquainted, and of whose achievements we are all of us proud. I speak of Professor Elihu Thomson, the man whom I believe to be the greatest living electrician. (Applause.)

ARC LIGHTING—ELECTRIC WELDING.

PROF. THOMSON: I suppose I am to be called upon to-day to represent the fire, the earthquake and the hurricane. I feel that the vastness of this representation is appalling. I will do a little toward such representation, but I will make it rather mild, so that you need not fear the fire, the earthquake or the hurricane.

We are here to celebrate the completion of the first ten years of the great industry of electric lighting—great now, but ten years ago very slight indeed. We are here also to recall circumstances, to recall incidents of our early experience in this industry and kindred industries.

I will begin by recalling a few circumstances which happened to me in 1889 and which made a lasting impression. It was my privilege to visit the Royal Institution in London and there inspect the original manuscript records made by Sir Humphrey Davy and by Faraday—the two great names, lying, as it were, at the foundation of the sign, at least, of electric lighting—to inspect also the apparatus and even to handle the apparatus which Faraday used in his early experiments. I can say that I did it reverently, undoubtedly. These two names are coupled with the beginnings of our great industry. Sir Humphrey Davy was the first man who ever saw the electric arc; the first man who put two wires together tipped with carbon, drew them apart and got the flame which we now call the electric arc. He called it the electric arch, I believe, or an arch of flame. I saw the record of this original inscription, and the inscription in Davy's rapid hand that this was a gorgeous experiment. He did not, apparently, realize what it might come to as a gorgeous industry, as a splendid industry, to be established to flood the world with artificial sunlight, to utilize the stores of energy which are in the bowels of the earth—taken out, put under the steam boiler in the form of coal, chemical action allowed to produce heat and, finally, to produce electricity and, as it were, turn back upon us the radiant energy of the sun which charmed on this planet probably millions of years ago. That is what we are doing. I say he did not realize that, probably; but he simply admired the experiment from the scientific standpoint. His enthusiasm was that of the scientist and it is a worthy enthusiasm in all cases. The scientists may discover something which may not, at first, have the slightest connection with practice, but sooner or later, no matter what the idea, no matter what the discovery is, whether small or great in a scientific sense, I have full confidence that the time comes eventually when such discoveries are utilized in practical life as this discovery of Davy's was.

It was quite a contrast—the difference between Davy's style of recording his experiments and Faraday's, and there is that contrast even to be seen in their work. Davy was, as it were, brilliant, jumping from one thing to another and getting there by a great leap; while Faraday's was the painstaking work of the scientific investigator who thought out carefully what he was about, and, when he had concluded his experiments, wrote out just as carefully what he had obtained. The records of Faraday's are models of neatness, they are models of precision in every way. I recall this as a reminiscence. It is a late reminiscence, but it carries us back to the time when Faraday was at work in the discovery of the action of currents in magnetic fields. It is to Faraday that we owe the discovery of the principle which underlies the generation of current by the dynamo. It was he who moved armatures in magnetic fields. It was he who found that the magnet was capable, under proper conditions, of yielding currents. He was perfectly satisfied to investigate that fact and the condition under which it occurred, and he expressed his confidence that the time would come in which these facts and principles which he was investigating purely from the scientific standpoint would be applied on a large scale in practice. He said it was not for him to do that, however; there were others who would take up that work.

Coming down to more recent periods after these investments we find occasionally efforts made to employ these principles in procuring light, and one of the earliest was the running of a lighthouse by a magnetic machine constructed in accordance with the principles which Faraday discovered; but it was a solitary instance for quite a number of years. Then came upon the scene M. Gramme with his wonderful dynamo machine, the elements of which were known before; in fact, were known when Faraday made his experiments and published them, were known in a crude way in other prior types of machine. In fact, the very principle on which the Gramme dynamo was founded were well known, but the construction of the machine was unique, and it was afterwards found indeed that this construction was, in the literature, due to Pacinotti, an Italian professor, but it had rested in obscurity for a number of years. Gramme, however, constructed a machine which would produce electricity economically, and he applied it to the production of light by the electric arc. He was, perhaps, the first to time that impetus which resulted, in a few years, in a considerable expansion of dynamo electric machinery as applied to lighting. These experiments of Gramme were carried on for a few years. His machine, I think, was built about 1869, and it was not until five or ten years had gone by that the machine began to be known in the scientific world. I saw a small Gramme machine about 1874, and it was a strikingly excellent example of a dynamo. All we had to do was to turn a little crank and a wire was heated to bright incandescence, apparently with very moderate effort, showing that the economy of the structure was high, that there was really very little waste, very little power being thrown away.

One of my reminiscences is that I met M. Gramme in 1889 at the Paris Exposition, and I found him to be a retiring, modest man who bore his honors very well indeed, but who had the peculiarity of never appearing in public when he could help it. It is very difficult they tell us, to get him out where he can be seen, and he only appeared on one occasion of the meeting of the Electrical Jury at the Exhibition. I think we should honor Gramme, not, perhaps, for the fact of his discovering a principle, but for the fact of producing for the first time, a type of dynamo which was really well adapted to use in the industries. Before his time there had been discovered an important principle in dynamos ; that is, that a dynamo could start itself— magnetize itself and furnish its own magnetic field, as we term it—the re-action principle, it is called. Even this idea came only by degrees, and was finally elaborated by a number of observers about the same time, or very nearly the same time, but even at the time this reaction principle was well worked out, the machine was not such a structure as Gramme produced.

Leading on from Gramme's time, we find the Centennial Exhibition, and there we find in the exhibition an exhibit of Gramme apparatus, and this exhibit certainly showed some remarkable advances. There were arc lamps in operation, but there was also a little exhibit which was a very striking one ; two Gramme machines, one driven by a belt and connected to the other, the other driven by the current developed by the first machine and working a little pump, producing, as it were, a miniature cataract of water ; a very striking experiment indeed, and one which we now see applied on a large scale in the transmission of power. We had in that experiment the production of electricity from steam power, its conveyance by a wire only 10 or 15 feet across the space reserved for the Gramme exhibit, and we had the machine pumping water and producing a miniature waterfall. We sometimes reverse that process now. We have the waterfall and we turn the machine, then we carry the current a distance and we take the power, put it on a belt and use it to drive our machinery. These are precious reminiscences. They show us the beginning of the great industries which are now developing.

I took up the subject myself of investigating dynamo machines about the year 1874, and began the construction of small models. My attention had always been drawn strongly toward the electrical fields, and it might be of interest now to recount some of the difficulties experienced in the early days. I must not leave out here that the Gramme apparatus was not the only machinery devoted to electric lighting which was found at the Centennial Exhibition. An enterprising American firm, Wallace & Sons, had constructed machinery known as the Wallace foundry machine, based on the ideas of Professor Farmer, the venerable electrician, and they applied these machines in the Centennial to the lighting of the ground at night, and the lighting of Machinery Hall, in part, and the whole exhibit of the Wallace-Farmer machine, and the apparatus showed that we had in our own country the nucleus of an expanding system, had it been pushed and caused to progress as the Gramme machine had. Even the machinery shown by the Wallace people was, some of it, more advanced in type than the Gramme apparatus.

From this time we find the arc growing by degrees. We find that in 1878 the Jablochkoff candle is lighting streets of Paris, the arc lamp, for the Jablochkoff candle is only a form of the arc lamp. We find along the two sides of the Avenue de L'Opera a system which had, however, a comparatively short life on account of its expense. The lights were certainly very beautiful. The Paris Exposition of 1878 showed this apparatus in use, and alongside the Jablochkoff exhibit I remember distinctly seeing the ice machine of Pictet turning out tons of ice daily by steam power in the same room with the Jablochkoff exhibits, and Pictet was at that time well known, on account of the fact that he had liquefied those gases which formerly had been regarded as incapable of being liquefied. He was the man who put such pressure and cold to bear on oxygen, nitrogen, and other gases which up to that time had been regarded as Pictet's gases, that they were turned into liquids, and even hydrogen, the thinnest of them all, had yielded to his persuasion.

To recount my own experience in electric lighting, I built a small dynamo about 1870 which would run an arc light. It was my first attempt at a machine of that size.

It was successful and it led to the construction of other dynamos. When we came to the commercial end of the business, which began somewhere in 1878 and 1879, we found it was not enough—not by any means, to build a machine to run a light. There were difficulties to be overcome, and not the least of those was the getting of steady power to run the machine. I could tell story after story of the discomfortures depending largely on the absence of steady power or the presence of unsteady power. I remember distinctly that our first machine that was intended to be a commercial machine, and, in fact, the first machine which embodies the principle used in the Thomson-Houston arc apparatus—the three coil armature—was a machine capable of running four to eight lights in series. In fact, the three coil construction had never been used in any machine before, and this machine was a large machine. I remember distinctly that when the machine was put up for the first time—I had wound every inch of wire myself and insulated the whole thing myself—the machine was elevated on a planer bed in the little shop in Philadelphia where it was made, and the belt from the engine, which they called a 10 horse power engine, but I do not think it was more than five, was put on the machine, and it was found necessary to tighten up the belt back to the engine. The machine could only be driven at a very moderate speed, and it astonished the machinists around to see how a thing which apparently did not touch anything in revolving, could use up so much power. Everybody was confident, they were all confident, those that had anything to do with the construction of the machine, that that would not take anything, that that engine would do it, that it would run a dozen machines. There was nothing to do but turn that machine around in air.

Another incident, in this same connection, I may mention ; it is rather an amusing one. We had got into making two or three machines in a small shop in Philadelphia, and a man came from the other side of the street, where he had a small establishment, and he said he had just the motor for the machine. He put his foot on the pulley of the dynamo on the floor and pushed it around. He said, " I have just got the thing that will drive that machine." I asked him what it was. He said, " I make a little sewing machine motor that runs sewing machines very nicely ; why do you put such a big pulley on that machine ?" I told him that if he would come in sometime when we were running the machine we would show him why the big pulley was on. He did come in later when the machine was under power. The power was a very bad power. It was so poor, I found that the crown sheet of the boiler had been burned out after testing the machine, and the whole contents of the boiler had escaped into the fire-box. Fortunately there was no explosion and nobody was hurt. He came in and saw this machine operating with a big pulley ; the belt on the one side being tight, the other side comparatively loose, and they showed him that by pushing the machine up and tightening it, it did not make much difference. There was still the pull there, and he was very much puzzled, indeed. He looked the machine all over and all around, to see if there was anything rubbing between the armature and the field, and he went away and said he could not understand it. He came to me a few days later and said he had got it now ; he understood it all perfectly. I said, " What have you made out of it ?" "Oh," he said, " I see it ; that machine makes electricity in a globular form, like globular lightning, and when it gets hold of that machine it just holds it there." (Laughter.)

In starting our arc light experience, our first apparatus, our first machine, the one I spoke of as being mounted on a planer bed and finding such difficulty to drive it, was put up in a bakery in Philadelphia, where it was used all night and it was rather tenderly nursed by us. We had to be up there nights giving it as close attention as many babies require. Sometimes we were up all night attending to this baby, and under conditions which were not altogether agreeable in mid-summer either, because, as you know, bakeries require pretty large ovens, and there is a good deal of waste heat about. The temperature by the thermometer in the room was frequently 140, and to live in that all night was somewhat difficult, as you may know. Well, I found that I could only do it by doing one thing? That is, I used ice water in excess. They tell us we must not drink ice water, but I must say that ice water saved me there. I believe in ice water on a proper occasion. (Laughter.) The two parties that were working with me, Professor Houston and a gentleman named Mr. McCollin, who was somewhat interested in the development of the lighting apparatus, thought I would kill myself if I stuck to ice water. They did not recommend anything else. I told them if they did not stick to ice water they would find they would be the ones who would suffer. We were working the machine for some few days in this high temperature in mid-summer, when both came around one day, and one said, " I have been rather sick. I cannot stand this much more ;" and the other said, " I feel so, too ; I have got symptoms of sunstroke, I cannot stand it." I said, " I told you so ; if you had stuck to ice water you would have been saved." I certainly kept my temperature within limits, but I had to suffer for it in other ways; the perspiration dripping through every pore, and the ice water no sooner entered my system than it was out again through every pore in my body. I stood the racket, however, and came out unscathed.

We then found that parties were interested in the development of electric lighting and at last a company was organized which is now the Thomson-Houston Electric Company. It was organized in a modest way in the little town of New Britain, Connecticut, where I removed. I had previously been teaching in Philadelphia in the High Schools, and I became electrician of this small company. Before it was organized, an exhibit of apparatus was made at New Britain in a basket shop, as they called it—an old wooden building used at one time to make baskets—and there happened to be old machinery in the shop for the former use of basket making. It was turned into an electrical exhibition; that is what it amounted to. The lamps were scattered around the building. There was an adjoining building with a motor which was driven by a current supplied from the main building; there was an engine which had the hardest work to furnish power, and the man in charge told me one day that the steam was getting down on him, and he had taken a lot of those basket machines and burned them; and he asked me what I thought about it. I said it was all right so long as he kept the lights going. But I have no doubt that many of you in your early experience of electric lighting recall incidents somewhat akin to feeding hogs into the furnaces on Mississippi steamers, in order to keep up steam. There was need at that time of something more inflammable than coal, especially when the steam pressure gauge was going down at a lively rate. There was no let-up in the dynamo. The dynamo must exert its back pressure. It has a certain current and a certain torque, and if we are using steam at sixty pounds we may be able to keep the thing going, but if we are using steam at forty pounds we are on the ragged edge of despair very soon, and we are forced to take heroic measures, even if it does mean the sacrifice of a lot of basket machines.

These were the beginnings of our experience. We soon got into another shop at New Britain and began the making of apparatus for commercial use. Even here we had the difficulty of power; steady power was what we wanted, in order to be enabled to tell what we were doing, and I have no doubt that all those who had experience in the early days with electric lighting felt the necessities that we felt. But if anything has done more than another thing to develop the steam engine it has been the electric lighting. I think the steam engineering business owes as much of its present development to electric lighting as to anything else, in fact, owes all of it nearly. The engines which were good enough to drive mill machinery and to drive ordinary machinery, whether the speed ran up or down, were not good enough to keep a steady glow in the lamp. They were not good enough to keep up just the same pressure and just the same volume of current under the conditions of practice, and the engine builders soon discovered that that was the case, and I may say that we have here in Providence the representatives of some of the most progressive engineers, who were the first to recognize the fact that the old style engines were not altogether the best suited for electric works—the Armington and Sims people.

After we got into operation our difficulties were not by any means over. We had to develop all sorts of devices, we had to overcome difficulties which were constantly arising to discourage us and dishearten us, but, by keeping at it, we finally succeeded in getting our apparatus where it could be taken care of by an ordinary man; where, in other words, we could put it in a factory or in a station and not require a highly skilled electrician to look after it.

When this was accomplished, we were met by other reverses. The Brush Company saw our beginnings of success. They were then the chief parties in the field of arc lighting. They bought up the majority interests in our little company in New Britain, apparently for the purpose of swallowing us and laying us on the shelf, to use a common expression. Subsequently, however, in the same year certain parties in Lynn purchased the majority interest in the stock of what was then the American Electric Company, of New Britain, and started operations in Lynn. The Brush Company, I may say, as you are probably aware, now has been swallowed up by this infant that they tried to swallow. Such is fate. (Laughter.)

I need not prolong this statement much further. I have merely to say, what you all know, that we have supremest confidence in the expansion of the electric industries. We are absolutely certain that our business is going to be greater and greater as time goes on. We are sure that we are living in an electric age, and, I may say, that we look to you, gentlemen of the National Electric Light Association, and we are ready to state our obligations to you fully for that which has made it possible for us to carry on our works for the commercial expansion. We look to you to see that the country is covered with plants. You have done noble work in the past. You have done more than the people fully realize, in standing at the times when discouragements came, at the times when things were not altogether as bright as they might be, in fact, when the lights were not as bright as they might be, or as steady as they might be—in standing in the breach with us and overcoming the difficulty—with you it was the difficulties of commercial exploitation, the systematizing of those things which concern station operations and commercial developments. For ourselves, we have had to overcome difficulties, and to provide for this and that in the way of invention and development to manufacture. The work will go on progressively. We have calls now, to-day, for dynamos up to 500 to 1,000 horse-power, where a few years ago we thought it would be an unusual thing, it was indeed an unusual thing to have 100 or 150 or 200 horse power machines spoken of, and it looks very much as though in the near future machines of much larger capacity would be demanded for electric installations.

I am down on the programme to-day to say something about electric welding. I was going to say here that I did not know exactly when that art was discovered, and that I believe that the formation of the National Electric Light Association was one of the steps in the process, figuratively speaking. (Applause.) It is gratifying, indeed, to see the electric welding operation going on here. These meetings undoubtedly bring together and harmonize the various members of the electric light fraternity, the men who produce the machines and apparatus and carry on the manufacture and the men who use them in commerce. Our interests are undoubtedly common. Our interest is to produce the best that can be had and to use it in the best way possible.

Coming now to the actual, not the figurative, electric welding, I may say that my time has been largely given lately to electric light matters, rather than to welding. It was my fortune to come upon the fact, and develop the fact, that metals could be worked, welded especially, and so on, by electrical heating and to apply it in practice.

The art is a growing one and quite a number of machines are now in active operation doing this kind of work.

I may touch here upon a matter of interest which is akin to electric welding, and that is, the general subject of electric heating. We are sometimes asked the question as to whether it will ever be possible to heat our houses by electricity, whether heating this, that and the other, can be done. I should answer that question as I have done frequently. It is not at all likely that we will ever heat extensively by electricity, unless we can find some way of converting the energy of coal into electricity far more directly and less wastefully than is done in steam engines of the present day. When we consider that under the very best conditions, with the very best engines, we can realize only a small percentage, ten per cent., perhaps, of the energy of the coal, the heating energy of the coal, in electricity and that when we turn that ten per cent. of electricity into heat we simply get nothing more than ten per cent. (that is the most we can get, and we generally get a little less), due to waste here and there, it is evident that we cannot afford—it is not likely that we can afford—to burn nine pounds of coal to get the heating effect of one pound of coal, whereas, by burning the coal directly, near at hand, we can use the heat directly and in almost full amounts. I noticed that a part of the discussion yesterday, as reported, was the utilization of the waste steam from the electric light plant for heating purposes, and, indeed, that seems to be a direction in which much valuable work can be done. There you have got through, as it were, with the steam; you have got all the power you can get out of it, or nearly all, and you have got an immense amount of heat left which is good enough for general heating purposes. There is a case, of course, where we can combine the two, not developing the heat by electricity, but rather taking the heat that is left over after we have got our electricity and using it for heating; but, of course, exhaust steam does not apply to special cases where the heat is required to be very high. In that case, we may find a moderate expansion of electrical application, as in cooking on a limited scale. It is so simple a matter to turn on a current and turn it off, getting a moderately high temperature out of the resistance through which the current passes, that there is not any question in my mind but what there is to be a considerable expansion of heating apparatus worked electrically, where the conditions of economy are not so pressing as in the case that I have mentioned in general heating.

I might close my remarks by simply stating, that, in regard to the electric railway, I hope indeed to live to see the time when some of our larger roads will be in operation, as they should be and can be, by electricity. I hope, also, that the time may come when we shall have at our command an easy direct method of obtaining electricity from fuel. That is the great cry nowadays, can we burn coal and obtain electricity directly from the coal without going through the steam engine and boiler, which must involve a great loss. It almost seems, from all that we who are actively engaged in looking up matters in this connection can say, it almost seems to us that we must wait for some new discovery, for another Faraday to come forward and show us principles which are not now known; some relation between electric energy and heat energy, whereby we can convert even 35 or 40 per cent., we will be satisfied with that, of the heat energy into the electric energy. We hope it may be so. But look what it means if such a thing should come about. Our electrical industries to-day would be of pecunious character. The steam engine would disappear. The steam locomotive would disappear. The steamship would be propelled no longer by the steam boiler, and the burning of fuel under a steam boiler. That fuel would be burned, undoubtedly. We should have to rely on the use of fuel in one way or another, but it would be burnt to produce currents. The apparatus which would propel the steamship would not be a steam engine with its reciprocating motions and its racking strain, but it would be that quiet rotary motion which characterizes the modern electric motor. It is not at all impossible to construct machines of that kind which would work up to many thousands of horse power, and thereby parallel the modern steam engine which is used on all steamship lines.

Thanking you for your attention, I conclude my remarks. (Applause.)

DISCUSSION.

MR. WEEKS: While listening to the delightfully frank and pleasant expressions of experience this morning, it occurred to me that it might be of interest to the Convention to know that in Kansas City, where is located the oldest Thomson-Houston central station, we are still operating some of the original 10 light machines, built by the original American Electric Company in the old factory in New Britain, of which Professor Thomson has told you. Using the metaphor of the gentleman from Boston, it might also be interesting to the Convention to hear me state, that equipped with that tackle, for which, by the way, we paid right handsomely (laughter), we did not come home, and we do not stand before you to-day, with an empty swing. (Applause.)

THE PRESIDENT: I presume that that was the machine that they burnt the basket apparatus up to test.

THE PRESIDENT: One of the most important branches of our industry, one that has enlisted energy and capital to a very great extent in the last three or four years, is that of propelling our street cars by electricity. We have with us this morning, and I take pleasure in presenting him, Mr. F. H. Monks, of the West End Electric Railway Company, of Boston, who are actually operating more miles than any other system in the country.

ELECTRIC RAILROADS.

MR. MONKS: Mr. President, ladies and gentlemen: As late as yesterday afternoon I was requested by Mr. Whitney, the President of the West End Street Railway, of Boston, to appear hear to-day to represent the company before this Convention. I must beg your indulgence at the outset, by reason of lack of time, for any preparation of extended remarks. The business of electric street railroading has no glorious history like that of the telephone, the telegraph, or the electric light. We have but a meagre record up to date. We are yet in our infancy, and we expect to live more in what we might call a glorious future. The records show that in 1835, Davenport, of Vermont, exhibited in Boston an electrical locomotive. That, I believe, is the first record of any electrically propelled machine of any kind. In 1848, Farmer showed a locomotive with a car attached, which was capable of carrying one or two persons. In 1852, Congress appropriated $30,000, and the money was expended by Prof. Charles G. Page, who experimented with an electric locomotive, using batteries of the Grove type. The experiment was only partially successful and the work was soon discontinued. In 1850, Thomas Hall, of Boston, made an electrical locomotive which was exhibited at the Mechanics' Charitable Association Fair in Quincy Hall. It was at that time the marvel of the day. But few understood it, and it was looked upon with wonder. In 1860, Hall exhibited an improvement upon his previous locomotive. It ran upon a circular track, and gave real evidence of a practical every day machine. It was named the *Volta*, and, I think, is yet in existence. As we all know, Siemens used a third rail for moving an electric locomotive in Berlin, in 1875. At Scranton, Pa., we find that there were three cars run in the spring of 1887, with motors on the front platform. The first road, perhaps, to be operated on any extensive scale was at Richmond, Va., which started operation under the Sprague system, in the spring of 1888. Before the close of the year 1888 some 40 cars were in operation. That, practically, brings us up to to-day. That is practically the history—all the history—of electric street railroads. Therefore, as I say, we are living to-day more in expectation of what the future may have in store for us, than in any glorious past.

I have been told by Mr. Foote, your secretary, that this a meeting at which reminiscences may be indulged in, and, therefore, I speak of the time when I first went to Richmond, in the spring of 1888. It was in May of that year that I first went there, and there I received my baptism, as it were, in regard to electricity. I am in no wise an expert in regard to the matter of electricity, nor am I scientific in that sense. I simply have to do with practical operations of roads. But I was very greatly impressed when I went to Richmond, and I became thoroughly convinced, when I saw what was being done by Mr. Sprague and his fellow officers in the company there, that we were just entering upon the threshold of a new era in regard to the matter of street railroading which promised magnificent results.

I went afterwards to Jamaica, in Long Island, and I saw there what is known as a double overhead wire trolley system. It was a very curious sight to me then, and would be, undoubtedly, now. The road-bed was a very poor one. It was very much out of order. The cars were very much worn and dilapidated, and the whole thing might be looked upon in the light of a by-word in street railroads. I noticed that the road-bed was in shocking bad shape, that it was difficult for anybody to keep in his seat, and I noticed that on the back platform of the car were carried sundry and divers pieces of rail, and upon asking their use, I found that the conductor used them to jump the car on the track when it jumped off, as it frequently did. I noticed again, too, that very nearly, if not quite, all the windows in the car were broken, and, upon inquiry, I found that the overhead line was in such bad order that the trolleys were continually falling off and coming down on the sides of the car, and breaking all the windows in that way. I went up to the middle of the line, where the superintendent's office was, and I went upstairs into a room which had a conglomeration of all sorts of street railway appliances that had been put there during a great many years. I saw on one side of the window a salt box with a drum head cover to it. It was a curious looking thing, and I asked the superintendent what it was there for. "Oh," he said, "that is my telephone. I have that attached to the wire outside and I can hear, as I sit at my desk writing, the car coming along the line, and if it goes off the track I know it, and then I go down there and help them put it on." (Laughter.) As a matter of fact, in a few moments after that I commenced to hear a confused sound in the telephone, very much the same as if a small boy was in the next room hammering tacks into the floor, and it continued for some time. I said, " I suppose that is the car coming." The superintendent said, " Yes, that is the car." It grew louder and louder. I finally said, " She seems to be making noise enough." " Yes," said he, "but she is all right; I can tell when she is off the track. You need not fear."

I also saw a primitive road at one time in Binghamton, in New York State, where they had a single overhead trolley system. Of course, those things now are matters of past history, and we come to what is the electric railroad of to-day. Perhaps, before that, I might speak of the matter of the introduction of electricity from street railways in Boston.

On the first day of January, 1889, after several months of preparation, the first electric car was started under the Sprague system, and later, the Thomas-Houston system put in operation in Cambridge. Since that time there has been no backward step, and there have been continued and renewed expressions of opinion, both by the officials of the company and by the public generally, of confidence in the system of propulsion of street cars by electricity. Sundry and divers experiments have been made in regard to the matter of storage batteries. Those you probably are all familiar with. Perhaps, there is no *ignis fatuus* on the face of the earth which is so seductive to the street railway man as the idea of a storage battery. But it is an *ignis fatuus* up to date. We have never been able to see anything in it. We have always found that it led us on some wild goose chase. To-day we felt very much as if we had a mind to go fishing, and we started and bought a $50,000 outfit, and we went down to the stream where we supposed the fish ought to be. On the way we met several of our friends and neighbors who were returning, each with his fishing equipment on his shoulder, and we say to one, "Have you been fishing?" "Yes." "How much did your equipment cost you?" Well, one man says, $5,000; another man says $50,000; another man says $250,000, and another man says $1,000,000. Well, we say, "That looks like a pretty expensive outfit; did you catch any fish?" "Well, no, we didn't catch a fish, but we had a bite." And that is about where we are with storage batteries to-day.

We have had our difficulties in Boston, of course, but we have also a glorious history to record in regard to what we have done. Last Summer, during the visit of the Grand Army to Boston, we carried on our entire system 3,000,000 of passengers in one week, and out of the 3,000,000 we carried more than 1,000,000 on our electric cars in one week, and that without the slightest hitch of any kind, without any trip being missed and without any person being injured in any degree. (Applause.) At present, we have 60 miles of electric track with something over 300 cars. We are running about 18,000 miles a day, electrically, or about three-quarters of the distance around the globe, and we are carrying from 100,000 to 125,000 passengers by electricity, The experiment, if such it may be called at this late date, in Boston has passed to a stage where the public not only consents to its extension, but actually demands it. From all the quarters, and we cover a very large area, having some 260 miles of track out through the populous towns and cities surrounding Boston, we have constant demands and repeated demands, and urgent demands, for the immediate introduction of the electric system, so that where it has been a matter of grave and great difficulty here to pacify the public mind respecting the matter of introduction of electric roads, with us in Boston it becomes now, simply a question of not getting in too quickly, too fast. I mean in the sense of saving ourselves the investment of a large amount of money in machinery, which, next month or next year, may be regarded as inadequate. But after all is said and done, we are but in our experimental stage, we are in our infancy. Much remains to be done by the electric companies in regard to the improvement in motors. Much remains to be done by the electric companies in the way of cheapening their product so as to give it to the railway companies at a very decidedly cheaper price that it can be sold to-day. Much remains to be done to perfect the system in regard to the proper form of car to be used, in regard to the proper form of rail to be used, and a thousand and one details remain to be perfected in order to make an electric system in a metropolitan city a great success. They say, there is nothing new under the sun, and, therefore, sometimes we are forced to go back to first principles in order to determine the best way to conduct our business today. Having given the subject careful consideration, I am very strongly of the opinion, and my opinion is strengthened with the lapse of time, that the future electric street railroad will not use its motors under the car. I do not believe that it is possible for a motor to be built to be used under the car which will give that degree of life and duration which the rough and hard and tough usage of a street railroad is bound to impose. I think, on the other hand, that the electrical locomotive or motor car is going to be the Moses which will lead us into promised land. For many reasons the electric locomotive is decidedly preferable to the use of motors under a car. The first one, and perhaps the most important, is the fact, that in Boston, in Providence, in Worcester, in fact, all the large New England cities, a double equipment of cars is needed. We need motor cars for Winter use. We need motor cars for Summer use. What we want to find in the practical ends of the business, is a medium, or force, or power, which will enable us to draw our box car on the morning of the fourth day of July, when it is cold and rainy, and to use the same force or power to draw our open car in the afternoon of the same day, when it comes out fine and beautiful, and the thermometer registers 70 degrees. The present type of motor car, which is now so widely known, does not give us those opportunities, and I doubt very much whether any street railroad can afford to go into the problem of buying electrical motors,with all the electric machinery incident thereto, for two equipments, one for the box car and one for the open car.

As I have said, gentlemen, I very greatly regret that I am unable to give you a long and glorious history of many incidents connected with this business. I am listening here to-day with a great deal of interest, and learning a great deal in regard to the matter of electric science, and I know that in Boston we are exceedingly anxious in every way to improve our electrical service, and all I have to say to you, gentlemen, is, that, while you have a big field, a large field in regard to the matter of electric lighting, in regard to the matter of telegraphy, telephony and other things, yet, at the same time, there is a great field for you in regard to the matter of street railway work, and when you will come to us with a truly practical scheme whereby we can avoid this double motor business, whereby you can give us something that we can depend on to work every day through 365 days in the year, we shall meet you with open arms. (Applause.)

THE PRESIDENT: I take pleasure in introducing to you this morning Professor J. Elfreth Watkins, curator of Engineering at the Smithsonian Institute in Washington, who will read a paper on the place of Electrical Invention and Development in History.

THE PLACE OF ELECTRICAL INVENTION AND DEVELOPMENT IN HISTORY.

PROFESSOR WATKINS: Coming from the Smithsonian Institute, I bear to you a message from the Daughters (the only descendants) of its first Secretary, Joseph Henry, a message of gratitude for the honor conferred upon the memory of their father by giving his name to the unit of self-induction.

And the honor is more highly appreciated from the fact that this is the first time in electrical history that the name of an American has been given to a unit in electrical nomenclature.

In considering the place of the electrical industries in history it has seemed advisable to discuss the question, relatively, by comparing the recent progress made in the practical application of this new power (electricity) in the useful arts and manufactures with that made during the last two centuries in the utilization of steam, which, a few years ago, was considered the greatest of the generated forces.

The year 1890 marked the bi-centennial anniversary of an event of the greatest importance in the history of mechanical engineering.

In August, 1690, Denis Papin published his celebrated memoir,* entitled, "A New Way to obtain Very

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*Acta Eruditorium, Anno 1690, p. 410-414.

Great Motive Power at Small Cost," in which the production of a vacuum under a piston, by the condensation of steam, is described for the first time.

The present year (1891) is the centennial anniversary of the granting of patents to Fitch, Rumsey and John Stevens, for the application of steam to boat propulsion.

During the 100 years that intervened between these two important events, the steam engine, invented and improved at the hands of Savory, Newcomen, Hornblower and Watt, had been made commercially successful, and the statesmen and political economists of every progressive nation believed that the new motive power was to be the prime factor in developing the resources of every civilized country.

During the decade of the 18th century (1780-1790) which corresponds to the ten years of the 19th through which we have just passed—the decade so rich in the progress of electrical science, the conclusion of which we are assembled to celebrate—the engine works of Boulton and Watt, at Soho, occupied a position in the public mind similar to that of the laboratories of Edison at Menlo Park and of Bell at Washington, in recent years.

For the next half century (1790–1840) inventive thought throughout the world was directed to the solution of the problems of steam navigation and steam locomotion, the results of which will cause the *Clermont*, the *Phœnix*, the *Savannah*, the *Sirius* and the *Great Western*, and the names of the two Stevenses, Fulton and Ericsson, Trevithick and the two Stephensons, Hackworth, Jarvis, Allen and Baldwin, to be remembered through all time.

The men whose genius taught us how to combine fire and water to drain the mine, to forge the shaft, to propel the ship, to haul the train, to drive the loom—have long been regarded as the greatest benefactors of the human race.

The origin and development of steam engineering mark an epoch which has thus far been considered the most important in the record of human achievement. Shall electrical engineering occupy an equally important place in history ?

The year 1891 also marks the centennial anniversary of Galvani's great discovery ; and the

Ninetieth of the publication by Volta of the principles of what has since been known as the voltaic pile ; the

Seventieth of Faraday's discovery (December 25, 1821) that an electric current can induce another in a different circuit, making it possible to produce continuous motion by electricity ; the

Sixtieth since Henry produced "motion by a little machine by magnetic attraction and repulsion," the principles of which had "never before been applied in mechanics" ; and the

Fiftieth of the granting of the patent to Morse for the electro-magnetic system of telegraphy ; and the

Fortieth of Professor Page's experiment with an electric locomotive driven by primary batteries on the Baltimore and Ohio Railroad ; the

Thirtieth of the invention of the Siemens armature ; the

Twentieth of the completion of Gramme's first arc light machine ; and the

Tenth of the application of the electric current to car propulsion from an overhead wire, by Dr. Finney, of Pittsburgh ; and the

Tenth of the establishment of electric lighting as an industry in the United States.

It seems remarkable that these important events should have occurred at intervals of centuries and decades. Truly the year 1891 is an important milestone in the progress of electrical science.

From the lips of men eminent in the principal branches of electrical industry, you have heard how the great departments which they represent originated, and how they have grown in public usefulness and in commercial importance.

No words of mine can add to the fame of Henry the discoverer, Vail the inventor and Morse the promoter; the great triumvirate who gave to the world the magnetic telegraph, the Ariel of the nineteenth century, bearing hourly tidings from every quarter of the globe.

Pioneers in the field of invention and improvement of the telephone have already spoken of this great branch of electrical industry, the time and labor saver which has done so much to add to the comfort and convenience of the home, the office and the workshop, and the perfection of which enables us to converse over long distances, permitting husband and wife, mother and son, lovers and friends, to hear the sound of familiar voices of those hundreds of miles away.

Ten years ago I sat in the little park on the American side of the Falls of Niagara, which was, for the first time, lighted by arc lights, the dynamo for which was driven by a water wheel under the Falls. I am told that the success of that experiment was what started men to thinking, ultimately resulting in the capitalization of the great company that is preparing to utilize this immense water power which for centuries has been going to waste.

Five years ago I stood on the banks of the River Bush, in Ireland, and saw a turbine water wheel turn the dynamo which furnished electricity for what was then the longest electrical railway in the world. Always accustomed to associate the consumption of carbon with locomotion, the utilization of a waterfall to drive a train seemed almost to border upon the miraculous. The possibilities of using the abandoned water power of this country for making light and driving trains, when fuel shall become scarce, which then dawned upon me, has grown in importance with the succeeding years.

The electrical industries are called into service in every branch of human labor. If we visit the farm,* we see the electric motor applied to the threshing machine; while telpherage is found to be an economical means of collecting and transporting grain and farm produce from the field to the store-house and railway station. One progressive farmer, controlling thousands of acres, sits at his desk and gives directions by telephone to overseers stationed at different points on his immense farm.

Who can tell what influence the discovery of Sir William Siemens, that about two candle power per square foot diffused by the arc light is sufficient to replace the sun in its action upon plant life, may have in the future upon floriculture and horticulture in the land of short days and long dismal nights?

If we enter the mine, we find the tunnels and gangways lighted by electric light, the electric drill is at work in the heading, the electric fan produces ventilation, and the electric locomotive collects the coal or ore from the miners in the chamber, and delivers it without heat or smoke to the steam railway for transportation.

If we sail upon the sea, our ship is guided by the magnetic needle and steered by electric gear; we see the sub-marine torpedo boat propelled by electricity; in the light-house burns the electric beacon; the electric search-light protects us from collision in the darkness and the fog; while electricity is put to a hundred other uses on shipboard.

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*One of the first applications of the electric motor was for a plow in France.

Upon the land we find in the United States alone (over 2,000 miles) enough electrical railroads in operation to reach from New York to Salt Lake City, if placed in one continuous line, and upon which nearly one million and a half of passengers ride every day.

We illuminate our public streets and parks, our railway stations and public halls, our offices and homes, by electric systems which ten years ago were undiscovered or in the experimental stages. By the movement of a single lever the area of a whole city is turned from darkness into the brightest day. Central electric light stations in America exceed the central gas lighting plants by over fifty per cent.

If we visit the printing office we find that the news is collected by electricity, the presses are driven by electricity, the papers are printed from forms containing electrotypes, an electric folder and paster completes journals which are conveyed to the street for delivery by an electric elevator.

Electroplating and electro-welding aid the metallurgist in the arts and in the workshop, and the electric current enables him to separate his ores and produce cheaply the new metal of which we know so little and expect so much. The chemist practices electrolysis and uses the battery everywhere in qualitative and quantitative work. The physician, puzzled in his diagnosis, finds by electricity a means of clearly elucidating the most intricate problems relating to the nervous system, and in various electrical therapeutic appliances a curative agent with which he successfully combats the nervous diseases which are so prevalent in this era of what we are pleased to call the highest civilization.

By electricity, frauds who feign sickness are detected in the hospitals; while capital punishment is inflicted upon criminals by the electric chair.

The biologist and anatomist, following in the steps of Galvani, ponder over its mysterious effect upon muscular nerve tissue, and wonder as to the future possibilities of utilizing electricity for increasing nerve force and prolonging life.

In the fine arts, the reproduction of relief work makes it possible to produce the replica to gratify the taste of the connoisseur. In photography, in sub-marine exploration, everywhere, the scientific investigator is assisted in his research by this great force.

In the household, electricity calls our servants, rings the fire-alarm, summons the policeman, and protects our houses from burglars at the doors and windows, and our safes by the time-lock. If we are so unfortunate as to burn gas—I say unfortunate, for each 16 candle power gas jet consumes as much oxygen as five grown persons—we light and extinguish our gas chandeliers with the electric spark. It can be made to pump the water, drive the ventilating fan, run the sewing machine, rock the cradle, and even boil the coffee.

The mechanic formerly dependent upon the factory, where, for the sake of economy, hundreds of employees were crowded in a few cubic feet of space, for a small outlay, is able to enjoy the independence of the self-employed by using the appliances which are placed at his command by the systems of electrical transmission of power. While the "factory girl," the class for the creation of which we have been taught to praise Arkwright, the founder of the factory system, may tend the loom, or operate the sewing machine, or other device, in comfort either in her own home or in apartments where proper sanitation and limited seclusion add to her bodily health and moral welfare.

Cannot some political economist find in the cheap transmission of power over long distances the basis for the solution of some of the social problems of the day?

Surely the men who have invented and improved the dynamo and perfected methods for the transmission of power over long distances, deserve the gratitude of their fellow men. They are entitled to, and will secure, a place in history beside other master minds, whose life work has been devoted to the discovery of methods for the utilization of the forces of nature which were unused until inventive genius found a way to put them to work.

And what of the future? Ignorant as we are of the nature of this marvelous agent, he would indeed be presumptuous who would dare to forecast it for even a decade. The electrical industries had their beginning coeval with the foundation of the nation, when the great philosopher, Franklin, combining scientific investigation with statesmanship "*eripuit fulmen cœli, sceptrumque tyrannis*," snatched the lightning from the clouds and the sceptre from tyrants. From the day of Franklin to those of Edison and Bell, America has been the home of electrical invention. And there is not a nation in the world in which electrical devices are used without employing the results of American genius and the products of the American factory. Well may the electrical inventors and manufacturers of America point with pride to what has been accomplished during the decade, the conclusion of which we celebrate to-day.

The telegraph, the telephone, the dynamo, and the many other results of their skill and genius exerted during the nineteenth century, will stand in history alongside the printing press, the reaper, the cotton gin, the steam engine, the locomotive and the other great epoch making inventions that have made the present era of civilization possible.

Mr. Pope: I beg leave to offer the folowing resolution:

"*Resolved,* That the National Electric Light Association assembled to celebrate the decennial anniversary of the establishment of the electric lighting industry in the United States, fully appreciating the value of the discoveries and inventions of Joseph Henry, heartily approves of the proposition now before Congress to bestow substantial recompense upon the daughters of the great discoverer, who during a life time devoted to science received no financial compensation for the benefit he conferred upon mankind.

"*Resolved,* That a copy of these resolutions be forwarded to both Houses of Congress."

The resolutions were unanimously adopted by a standing vote.

THE PRESIDENT: Mr. Monks, of Boston, has stated that street railway systems have no past; they have grabbed the present, and are going to secure the future. Unlike the street railway system, the National Electrical Association has a past, one extremely interesting and widely varying in interest. We have been promised in that direction a paper from Mr. George Worthington. Unfortunately, he is detained at home by illness, and Mr. Charles W. Price has kindly consented to respond in his behalf.

THE ORGANIZATION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

MR. CHARLES W. PRICE: Mr. President, Ladies and Gentlemen of the Convention:

A few hours ago I was informed that, owing to the absence of Mr. Worthington, I would be expected to respond to this theme—The Organization of the National Electric Light Association. Providence, with an Electric Light Convention let loose upon it, is not the best place in the world to collect your thoughts. This, you must accept as my apology for the hurried and brief remarks I shall make, and that they are brief no doubt you will be thankful.

Fortunately for me, though perhaps not for the Association, I was present at the birth of the National Electric Light Association, an organization which, through many changes of everything else, has never changed its name, and is still known by the title given it in Chicago six years ago. I think every line of the first Constitution and By-laws has been changed, with this exception, for when other portions of the programme failed, a report from the Committee on Amendments would be depended on, and such Committee was appointed as regularly as the Association assembled in Convention. These amendments were not always improvements. Having had an humble part in the construction of the first Constitution, you will understand of course I can speak from an unprejudiced standpoint.

The first Convention was composed of many of the pioneers in electrical work—energetic and progressive men. Next to those engaged in electric lighting, gentlemen representing the carbon industry were most numerous—not even excepting at that time the newspaper men—and our friends who dealt in general electrical supplies lent friendly and able aid at all times. No one seemed to fully understand why the meeting had been called, one delegate stating at the first session that he came because his parent company advised him not to.

The first meeting of the National Electric Light Association was held in the Parlors of the Grand Pacific Hotel, Chicago, at 11 o'clock A. M., February 25th, 1885, six years ago. Mr. William A. Hovey, at that time one of the editors of the *Electrical Review*, of New York, called the meeting to order, and stated that the call had been issued by his journal on the request of a large number engaged in the business of supplying electric light.

George S. Bowen, Esq., then with the Vanderpoele Electric Company, of Chicago, was elected temporary Chairman, and Mr. Henry Dwight Stanley, then and now and probably forever representing the Bridgeport Brass Co., was elected temporary Secretary. Mr. Bowen, on taking the Chair, spoke briefly of the bright future he thought was in store for the electric light, remarked that the science was "still in its infancy," and expressed a confidence that valuable results would grow out of the Convention. You all agree, undoubtedly, with Mr. Bowen's predictions.

A Committee on Credentials and Permanent Organization was appointed, consisting of the following named gentlemen: Charles A. Brown, of Chicago, C. J. Richards, Racine, Wis., George Herbert Wadsworth, of Cleveland (since deceased), Frank Ridlon, of Boston, and S. Baldwin, of Baltimore.

A Committee on Programme and Progress of Business (please note the title), consisting of about one-third of the delegates to the Convention, was appointed, and then adjourned for lunch.

On re-convening, Mayor Carter Harrison, of Chicago, welcomed the visitors. Speaking from memory, I remember that he said, that "Electricity was the most subtle of fluids, that it was the most powerful, the greatest agency handled by Man." "It was," he said, "The breath of Deity. It could rend the giant oak, melt the granite of ages, yet, in the incandescent light it was as soft as the down on a woman's cheek."

Then we all stood up and cheered Carter Harrison.

Prof. Elisha Gray also spoke a few words of welcome, and gave electricity the credit of being the greatest wonder of the century, and varied the infancy remark by predicting that we "were only on the threshold of its wonders." Then all applauded Professor Gray, and everybody present felt proud of his calling.

The Committee on Permanent Organization, which had been penned up in a room, and compelled to go hungry until the report was made, then filed into the room. The peaceful look on their countenances gave no indication of the strife and controversy that had occurred in that committee room, where they had been in attendance on the birth of this Association. The Committee was, fortunately, a comprehensive one, and from a host of candidates made admirable selections, as follows, and the report was unanimously adopted by the Convention :

President, J. F. Morrison, Baltimore.

Vice Presidents, H. M. Cleveland, of Hartford, Conn.; J. H. Yarbrough, Nashville, Tenn.; E. R. Weeks, Kansas City, Mo.

Secretary and Treasurer, William A. Hovey, of New York.

Executive Committee, George S. Bowen, of Chicago ; Wm. Hochhausen, of New York ; Gilbert Donaldson, of St. Paul ; Frank Ridlon, of Boston ; John R. Fletcher, of Akron, Ohio ; and George O'Connor, of New Orleans.

Mr. Morrison thanked the Convention for the honor, and in a brief address opened the Convention for the business that, as he said, had brought many of the members hundreds of miles.

The Committee on digest of papers and programme of business reported the following order of proceedings and topics for discussion, which I think will not be uninteresting to give in full here :

1. Incandescent lights, particularly in regard to length of circuit upon which they can be run with profit. (You will see, even at that time, these scientists and engineers were not working solely for their health.)
2. Locating and avoiding crosses with telephone wires.
3. Power and its conversion into light.
4. Electric light globes and shades.
5. The best modes of connecting dynamos with power.
6. Electric lighting by water power.

7. Rates and rebates on electric lights by the year.

8. The use of electricity as applied to motors.

9. When an electric light system requires No. 6 conductor, is it desirable to use Nos. 6 and 4 in the same line?

10. Will armatures become affected by frost when exposed in transportation?

11. Special insulation on guards to insulation of lines at dangerous points and places.

12. Street lighting; the best manner and modes of accomplishment, embracing the location of lights and running of circuits.

13. Experience and results in the use of underground conductors.

14. *Resolved*, That the fireman should receive more pay than the engineer.

15. Help generally.

16. Experience of electric light companies in the use of copper coated and uncoated carbons.

In the light of the present, the discussion which followed would prove very interesting, and in some instances laughable. But the Convention report, which was published, gives you all this, and I need not make lengthy mention here.

I remember that the Convention was astonished by the figures given by Mr. George Fletcher, of Dixon, Ill., of the cost to him per light. Some one asked him how much he paid his engineers—who was his engineer. "The good Lord is my engineer," said Mr. Fletcher. This he explained by stating that he employed water power, by means of which a turbine water wheel ran a saw-mill and other mills, and incidentally his electric light plant. Mr. Fletcher stated further that he received enough carbons to run his plant without cost, by diligently sending to the different manufacturing companies for "sample" lots. These statements very naturally caused much amusement.

Mr. Vanderpoele stated that electricity could be used for transmitting power. No one will dispute that fact to-day, or that Mr. Vanderpoele was one of the first to prove it.

Proposition 9, relating to the use of the No. 6 and 4 wire in the same line, was decided in the affirmative. Whether frost could damage armatures in transportation was answered in the negative by Mr. Vanderpoele.

The principal sections of the Constitution and By-laws as adopted were as follows:

ARTICLE II.

"The members of this Association shall be companies, firms or individuals operating electric light plants or manufacturing electric lighting apparatus."

ARTICLE III.

"Companies, individuals or firms engaged in the manufacture of machinery or apparatus connected with electric lighting may be admitted to associate membership by a vote of the Executive Committee. Such associate members shall pay the same dues as members, shall be entitled to seats at all meetings, but shall have no vote, shall be ineligible to office, and shall be entitled to the floor only at the request of the Executive Committee or presiding officer."

This Convention adjourned after two days' session, and with its subsequent history you are all well acquainted.

In conclusion, it is scarcely necessary for me to speak of the great usefulness and wide influence of this Association. Starting with a membership of less than fifty, it now has, I believe, several hundred, and it has been the means of promoting a fraternal feeling throughout the entire electrical industry, of at once bringing to the front the most meritorious work of the alert inventors, and, to an extent not easily calculable, made every electric light man acquainted with the successful and modern manner of conducting his business. Neither can it be said to have fulfilled its mission. There is much and still greater work to do, as this great science continues to expand. No organization, and I speak advisedly, has done so much to promote the best interests of the whole field of this industry as your Association.

That the good work, begun in doubt and with many misgivings in the City of Chicago six years ago, may continue to still greater usefulness and honor, is the sincere wish of your present speaker.

Mr. GEORGE M. PHELPS: I ask the privilege at this time of presenting a resolution lest I may not have another opportunity:

Whereas, The members of the National Electric Light Association assembled in its Thirteenth Convention have learned of the serious illness of Mr. George Worthington, whose genial presence is missed by all and whose conspicuous services to electrical industries in promoting the organization of the Association are recalled by all, it is

Resolved, That the Association hereby expresses its cordial esteem for Mr. Worthington, its appreciation of his many services, and its heartfelt wishes for his early recovery of health and strength, and that the Secretary be requested to forward a copy of the resolution to Mr. Worthington.

The resolution was seconded by Mr. Ralph W. Pope, and carried unanimously.

THE PRESIDENT: As representing the particular department in incandescent lighting, Mr. J. H. Herrick, First Vice President of the Edison Electric Company, of New York City, will now, I am pleased to say, address you.

INCANDESCENT ELECTRIC LIGHTING.

MR. HERRICK: Apart from the very great honor of appearing for the first time at the decennial celebration of electric lighting in this country, I find myself in an exceedingly embarrassing position. I hold in my hand an invitation which I received with much pleasure so long as I perused the first few lines. I got down a little further in it and I discovered that I was not called upon to make a set speech, and that if I could not make a set speech I might write one and it would be read for me. Now, you can imagine the condition in which I must be when I have never made a set speech and never written one. I am called upon, also, in a measure, to represent Mr. Edison, as I perceive from my invitation that Mr. Edison, as usual, declined to come or was not able to come. Now, I feel utterly unable to represent Mr. Edison in anything, even in the modesty which is his pre-eminent gift. (Applause.)

This is a Convention of reminiscences. I do not believe it is in the books, but it seems to me in preparing for this occasion so far as I might, that the original incandescent lamp has been omitted from the books. I claim that a man named Moses discovered the first incandescent lamp, because it was incandescent, it was a vegetable filament and it did not consume. (Applause.)

I think you ought to put down in your archives that that is where incandescent lighting first begun.

From that time to Thales—I think it was, Mr. Lockwood—and from that time on, somewhere in the neighborhood of 1820, the world was wishing for the return of that same incandescent light, but it did not come. I understand from some of the scientific speakers ahead of me, Mr. Faraday discovered, in the neighborhood of 1825, some method of running a powerful current over a large conductor through a low resistance incandescent carbon, and made, as my celebrated friend, the Professor, has suggested, a brilliant, beautiful laboratory experiment. I understand the light went along in just about that shape until somewhere in the neighborhood of 1875, when, thanks be to God, Mr. Edison, having completed the quadruplex telegraphic invention, was enabled to turn his attention to the incandescent light. What did he do? In some respects it was a misfortune, because under the old incandescent system we might have furnished, with a mixed conductor, a demand for the entire Hecla mine of copper, and I do not know but that pretty much all the rest of the copper in the world would have been wanted, and if we could have gone far enough to employ some of our surplus silver in the same conducting business, I am satisfied that on the whole we would have been better off than we are now. Mr. Edison reversed the previous arrangement. Now, I am getting on a little dangerous ground. I am going to attempt a few technical remarks, of which I am satisfied there is not a gentleman in the room who hasn't more information than I have. As I understand, this Humphrey Davy or other gentleman's lamp (laughter) required a very large conductor, and the resistance of the incandescent part of it was one-tenth of one ohm, and if we had used all the copper and all the silver I don't know that we would have found machinery enough to give us current enough to run it up to the requisite character of light. So Mr. Edison began at the other end and said: "I must make a low resistance carbon, and then I will reduce my conductor and I will make the thing commercially possible." What was the result? From one-tenth of one ohm, the filament in the globe of glass—in the vacuum in the globe of glass—resisted at first 140 ohms against one-tenth, and later on 240 ohms against one-tenth, meaning 1,400 times more resistance and 1,400 times less power, and there is your solution. (Laughter.) Now, the benefits of this incandescent lamp—here we are in a room; we have been here a couple of hours and we have used up a great deal of oxygen. The figures were given just now—every five feet of gas burner consumed nine square feet of oxygen and the room begins to feel oppressive. One of the principal advantages of this light is that we do not use any oxygen and we only produce one-fifteenth part of the heat, and we take the light into the domestic circle and we make life pleasant and happy, because the air is good. Now, I am very fond of parallels, and it seems to me that the incandescent lamp is very much parallel in many respects to human life. The great men of the past and present have elevated manhood and benefited the common community by the measure of resistance they have been able to offer to the obstacles, the trials, the disappointments from daily life. Just so our incandescent lamp, by the measure of its resistance so shall you measure the brillancy of its effect. Again, human genius, human talent may be overwrought, overworked, and cease to benefit us all. So it is in incandescent light, if overwrought by the current by which it produces its most beneficial result, it is destroyed.

Just before I come to the close, I would like to tell a story which I think especially applies to electric business. A young lady friend of mine was speaking to another lady friend, and said to her, "Annie, why did you refuse Mr. Hardcastle?" "Refuse him? I could never be happy with such a man as that. Why, he doesn't believe in anything. He has no faith." "No faith?" "No; he doesn't even believe in dreams." There is no man fit to belong to the electrical fraternity who does not believe in the scientist's dream. (Applause.) What we have achieved in the past was largely owing to the dream of our scientists put into reality. What we may expect in the future will depend upon by how much faith, by how much energy, by how much genius, we endeavor to realize the dream of these scientists.

That I am delighted to meet you, gentlemen, in this friendly manner goes without saying.

THE PRESIDENT: It was related that in the early days of electric lighting in the city of Boston, when the old Brush Company was afraid of their coal being exhausted, and there were two firemen in the room, that Frank Ridlon ordered one fireman to be thrown into the furnace to keep the steam up until the load of coal arrived. One of the survivors of the old basket factory in New Britain, who has come down to us from those early days of electric lighting in comparatively a good state of preservation, is E. Wilbur Rice, of the Thomson-Houston Company, of Lynn. We shall be glad to hear from him.

BEGINNINGS OF DYNAMO MAKING.

MR. RICE: Mr. President, ladies and gentlemen: It is necessary to state that this is entirely unexpected. I came here expecting to listen, not to talk. I have been greatly interested in all that I have heard, and with the reminiscences of Professor Thomson. I was very much interested to hear Professor Thomson speak of what he saw in London, and it occurred to me that I had a similar experience one time with Professor Thomson himself, when I visited the Central High School, one afternoon, after school, to examine some of Professor Thomson's old works. I saw there a dynamo which the professor assured me was the first one that he had ever built. This dynamo, curious to relate, was so wound and connected by Professor Thomson on different occasions, that it involved many of the principles which have since become well known, but at that time were unknown. He had the winding so arranged that it could be used in shunt, in series and in series shunt, which is practically known to-day as the compound winding and which is used so much in connection with incandescent lighting. Professor Thomson did not publish it at that time, and told me that he did not think he was doing anything particular. I may say, in this connection, that Professor Thomson did a great many things of this kind that were equally great, but which seemed to him so ordinary, and such a matter of course, that he neglected to say or do anything about it.

I was a student at the High School of Philadelphia at the time when Prof. Thomson visited Europe in 1878. Upon his return, I was greatly delighted to hear his enthusiastic account of what he had seen, and I know I was very much interested to learn that he intended to go into such a line of work. I remember one of the first large machines driven by power which was built by Prof. Thomson, and was used in a lecture at the Franklin Institute, given in the Winter of 1878-79, shortly after the Professor's return from Europe. This dynamo was driven by a steam engine belonging to the Franklin Institute, and was used to run a very brilliant arc light. In those days an arc light was quite a novelty, and I well remember the impression it made upon me, although I was quite a young man—a mere boy at the time of the Centennial Exibition. I well remember the exhibit, which was described by Prof. Thomson, of Gramme, and others, and, I may say, to that exhibit I owe all my interest in electrical science. Of course, I did not comprehend it at that time, but I took a great interest in it, and began thereafter to study it, and upon entering the High School, I found Prof. Thomson one who was quite willing to assist me in all endeavors.

The early days of the promotion of the Thomson-Houston Company in Lynn, at the old American Company, are, of course, quite familiar to me, as I was one of the first employees along with Prof. Thomson. In those days we were not quite so busy as we are at present, and although the factory was quite small the room was quite large for the amount of work we accomplished. I know on the upper floors of the factory it was quite a customary thing for some of the boys to build double rippers, and to exercise on bicycles. One of the first pieces of work upon which I was set, on arriving at New Britain, was whitewashing Prof. Thomson's office, and brightening up the machinery, and numerous other like employments. I must say I enjoyed it very much, indeed. There was nothing else to do, and I did not like to be idle. Prof. Thomson was engaged on work somewhat similar on some occasions. I remember well when he assisted in putting up a partition around his office in order to get a place where he could do some quiet work. The company was too poor or was unwilling to. buy electrical instruments, and Prof. Thomson had to make a great many with his own hands.

Perhaps, to give one an idea of the great advancement during the past ten years, I may state that a great many of the familiar words such as *volt* and ***ampere***, were at that time entirely unknown. We measured our current in webers, and I think that the word ***ampere*** was not generally adopted until 1881 or 1882. The first machine which was built in the old factory was a one-light machine which weighed something like 150 to 200 pounds. I remember well that we used to exercise our strength in attempting to lift it, and a great many succeeded. To-day we are building machines weighing 65,000 pounds. The output of those little machines was one arc light, measured in our electrical nomenclature, 500 watts. To-day the machines that I am speaking of will give an output of over 500,000 watts. This little machine of which I speak required about one and a half to two horse power to drive it, and the large machines we are building to-day require about 700 horse power. I think after the close of the year 1881 we had in use something like 100 arc lights all told. To-day I believe there are something like 100,000 arc lights in operation, This gives you some idea of the growth of one company, and one branch of its work, and there is no question but that the general electrical industry has developed in like manner. (Applause.)

THE PRESIDENT: First, almost, in the field of transmission and utilization of electrical energy for power purposes, and, I believe, the first to make a practical application and demonstration for the propelling of our street cars, is a gentleman whom we have with us to-day, so well known to you that I shall simply introduce him by calling his name—Frank Sprague.

SPRAGUE ELECTRIC RAILROAD.

MR. SPRAGUE: Mr. President, ladies and gentlemen: I feel somewhat embarrassed by being called upon to speak here to-day. The request that I should do so has been somewhat sudden. While the hum of the motor may be called the song of emancipation, like the hum of many another song, it is best when quietest. Since my early musical education was neglected, I am not able to compose music to go with it. I once made the remark that I owed much to Providence energy, and the industries of Providence, for some of the earliest success in electric railway work. A gentleman looked at me and said in a somewhat sarcastic manner, "I think you do owe much to Providence." Our thoughts to-day seem to run in a reminiscent past, and I will indulge in a little bit in that direction myself, simply because the commercial history of the electric railway is well known, while, perhaps, some of the inside history of it you do not know, and the story that I shall tell, in a very brief way, is nothing more or less than the story which is common to every earlier enthusiast in the commercial development of electric railway or electric light. I remember in 1879 I was on duty on board of a naval vessel of the United States on the coast of Japan. I had before that time been at the naval academy, graduating there in 1878. Just at that time Edison, Bell, and other electricians were prominent in the field, and there grew up in my mind a love for electrical matters, and the desire to be associated, in some way, with electrical developments. The United States Navy Department at that time was not very encouraging to any such ambition. I went the way of all other midshipmen, and drifted out to Asia, but the stories of the discoveries being made in electric lighting by Thomson, Brush and Bell drifted out there, and I became very nervous under it. At that time I was trying to invent an electric motor. I meditated very seriously sending a request to the Navy Department to be allowed to come home on a sailing vessel, as I could not well afford to come home in any other way.

Well, by some good intervention, I was ordered back to the United States, and I went to Ansonia, Conn., and saw an experiment in the transmission of power which greatly impressed me. Mr. Wallace, of Wallace & Sons, of Ansonia, is a man whose position in the history of this enterprise has never been fully appreciated. I went there, knowing him personally, and was taken through his factory, and he said, " Sprague, let me show you something." He had one of those old four-pole armature machines. He had connected it with a dynamo. He turned on the current, and pretty soon this thing was running two or three thousand revolutions a minute. He said, "It is no good." I said, "Why?" He said, "I will show you." And he turned to one of the men—a large, strong man—and said, "Get hold of the armature." This armature, I suppose, was about ten inches in diameter. He got hold, with the brake on the arm of it, and finally began to bring it down, lowering its speed, and finally brought it to a dead rest. In that simple experiment he outlined and he overlooked the most important fact that he had to deal with—that the energy which was being developed was not the sole question to be considered, but there was also to be considered its torsional effort multiplied by the speed with which it was traveling. Had Mr. Wallace seized on that single point, or had I, or had anybody else seized upon it at that time, the transmission of power would then have been very much advanced.

Mr. Wallace at that time, if I remember rightly, was building a machine invented by Mr. Farmer; certainly one of the earliest and most esteemed pioneers of electric science in this country. Mr. Farmer was then a crippled man, confined to his chair. He was attached to the torpedo station at Newport, and he had invented a machine for use in torpedo work on board ship. One of his machines was one of the first machines that I ever had the pleasure of dealing with. With a lack, perhaps, of some little formality, which is necessary in official life, I applied for the whole second floor of a machine shop in the Brooklyn Navy Yard. I think that was in 1880 or 1881. I got one lathe, and in that lathe I set up a Wallace-Farmer machine, and tried the first experiment I ever tried in the building of a dynamo or a motor. My work from that time fell off. My duties called me out of the United States, and it was not until 1882, at the Electrical Exposition in London, that I was brought to a consideration of the tremendous advance that electricity was making.

Few of you are familiar, perhaps, with the inside difficulties with which we had to deal in the history of the electric railway enterprise, and the amount which it was necessary to conceal from the general public. The contract for the road in Richmond was taken in 1887.

I had never seen the road. I remember to this day the impression that came over me. I had been talking with John Stephenson, the pioneer car builder of the United States, and he said, "I do not believe that any self-propelling car can operate under street car conditions. I am acquainted with 14 of them in the city of Paris." I said, "Mr. Stephenson, there has been one difficulty with those; not one of them utilizes the weight of the car for purpose of traction." The first machine that was built, was built for storage battery experiments on the West End in Boston. Subsequently, when I went to Richmond, I saw a grade of 10 per cent. My heart fell within me, and I said, "It is utterly impossible for any car to climb that hill." I came back to New York, and had some consultation in a retired room in New York that settled this question: Is it possible for any car to mount a 10 per cent. grade? Everybody said it is not, and I confess that I myself thought it was not. Shall we use a cable on that 10 per cent. grade and trust to electricity for the balance, or shall we change the gearing of the machine? We had a single geared machine. Mr. Johnson, who, I think, is a sort of John the Baptist in the electrical profession—a sort of forerunner of good things—said we had better find if we could get up that grade at all. Back to Richmond I posted. I started out one night when there had been an election, and when the streets were filled with a crowd of drunken men. We went down in great shape, and then just before us was this grade. I said to the Superintendent, "We cannot mount it." "Well," said he, "It will go up, and I will bet you five dollars I will take you up." We started, and we mounted the hill. When we got to the top, it had settled the question of traction on a 10 per cent. grade. It had settled, likewise, that the motors we had were altogether too small and too light, because they were hotter, perhaps, than the furnace in an electric welding apparatus. On getting to the top, we thought the best thing we could do was to stand still a little while. I remember one of my assistants, Mr. Green, was with me. I said to him, "Green, I think we had better send for some instruments, I think a little accident has happened to one of the machines." So we lay down on the bottom of the car until he brought those instruments. They were four strong mules, for it was necessary to get that car back into the car shed that night. As I say, we are indebted very much to Providence skill and energy for the success of that road. That fact brought me face to face with the fact that it was necessary to make a complete change on 60 machines in Richmond, in the matter of gearing. I was thoroughly at a loss what to do. There was no factory to which I could go to get that built, excepting one, and that was the shop of Brown & Sharpe in this city. I said to the foreman, "We have met the worst obstacle I have ever seen, in Richmond. We have got 60 cars we are under contract to run. If we fail there it will delay the electrical development in this country; we, likewise, personally, will go up. Now," I said, "I have got everything at stake. My associates have got every dollar at stake. The electric railway in this country is liable to be at stake. The road has got to go, and go it must. Will you do for me what I ask, and put as many men and as much money and material at my command for 24 hours a day as will be needed until I recover the position we have lost?" He said, "I will." They went to work and made probably the most difficult piece of gearing they were ever called on to make. In the course of four or five weeks, we started again in Richmond on the 2d of February, 1888. The gearing had all stuck for lack of oil. Then the next thing we found was that the armatures were too large.

and so we had to resort to electrocution ; we had to cut off their heads. We were using a 450 ground circuit, a machine that was covered with water and mud. Every field magnet had been wound and rewound three or four times. Our next experience was, that our commutators were going to pieces. We had tried no less than 65 different kinds of trolleys, and had not got one that would work reasonably satisfactorily. We were attempting to run motors in both directions, and with a brush that was difficult to handle, and, after trying a great variety of brushes, we finally settled upon square bars of brass about three-eighths of an inch square, and every time a car would go through the street you would see a shower of brass dust, so that we had the whole road marked from one end of the town to the other with a sort of golden path. The copper we were using was costing us nine dollars a day, and it was raw material. Subsequently we adopted the use of carbon.

This inside history of some of the work at Richmond has, of course, not ordinarily been told. I think the time has come, now, when there is no harm in its being told. I think that people would have looked on electric railways as out of the question, if they had known of the straits we were going through. In the last three years you have become perfectly familiar with the first geared machine ; that is, a machine that is concentrated on the driving axle and geared to the car axle. It was built by the Brown & Sharpe Company. They had one of the elevated railroad trucks in their shops some five or six weeks, and I think they are satisfied it will be the last they will have.

The Armington & Sims engine was the first engine we ever had, and the engines put in in Richmond have never to my knowledge been changed or caused the slightest trouble from that day to this.

The wire we first used was made by the American Electric Company in this city. The forgings we used were from Bridgeport, near by. So, almost all the material and the work done at Richmond either emanated from Providence or from places within a short distance of it.

There is a profession which owes much to the efforts of the electric railway people; that is the legal fraternity. I see a representative here of an enterprise and industry with which we had some conflicts—the Bell Telephone Company. I have heard since I have been here a criticism that I should have been an advocate of an overhead wire—one only, remember—and had taken upon myself to get out an injunction against the Metropolitan Bell Telephone Company of New York. About two or three weeks ago we had a very providential storm, and in what I considered one of the most beautiful portions of New York there was a magnificent line of poles, with 170 beautiful wires in all directions, and one to cap them, making 171 wires. A flaky fall of snow occurred, and we found this army of poles lying flat in the street. We thought that the telephone company had so well built its line that Providence never would aid us. But we immediately had a meeting of property holders and by the next morning we had an injunction against the erection or maintenance of any poles or wires on the street. I have been somewhat criticised, but I think it nothing more than turning the tables on that company which, for the past two years, has been so successful in sitting down on the infringers of its patents. I think the public has some reason to be satisfied, because the grounded circuit telephone is very largely disappearing from use. A more perfect telephone service is being adopted. Sixty per cent., if I remember rightly, of the lines in New York City are now underground, and we hope to see the balance of them there. As to the future of the electric railway, I heard with some interest what Mr. Monks stated. His objections to the double equipment have been based somewhat upon the cost. I think we all know the experience that the electric lighting apparatus has gone through, and none of us can doubt from that experience, that it is going to be made more simple, lighter, stronger, more reliable and at much less expense; so that the objection which he raises, I think, is not entirely a sound one. It is based upon past results, not upon future promises. The gearing of the present motor will disappear from the electric motor in the future, and it is a very near future. It will also be an electric motor driving direct without any reduction whatever. Its revolutions will be coincident with the revolutions of the wheel. The day of the gearing is fast approaching, and those who have had experience of gears with electric motors can surely feel encouraged by that fact.

Of late, I have been in exactly the position of Mr. Thomson, where the infant swallowed up the larger specimen, and I have also been very much in the position where the infant got very thoroughly swallowed up. But the electric railway problem in New York City—the question of rapid transit—is coming to the front. That we shall have there electric railway transit I think no man who knows the future of this industry will doubt. What form it will take no man will tell. While I am an advocate of one wire, if necessary overhead, I am an advocate of everything being put underground as far as possible. I do not believe in the theory of God's free air in New York City, where the air is monopolized by three things—buildings from 10 to 14 stories high, the elevated railroads and the Bell Telephone Company. But I believe in God's free earth, where we can go independent of grades and independent of weather conditions. We have a most remarkable example of the perfection of that operation in London. I had the pleasure of visiting the Suburban and South London Railway under the guidance of Mr. Hopkinson, the engineer, and I told him there could be no question of the success of that enterprise. I think information since received of the progress has fully justified that prediction. I thank you, gentlemen, for your kindness. (Applause.)

Mr. Weeks: It has been my experience in meeting, that there are always brethern who require a little coaxing, and I rise to ask from you the privilege of the floor for a gentleman from Chicago, whose modesty, characteristic of the city from which he hails, forbids him to rise and ask that privilege for himself—Mr. F. S. Terry.

Mr. Terry: I thought at this time a few remarks on the preliminary organization of the National Electric Light Association would perhaps be appropriate and interesting, and I will occupy your attention only a very short time. In the latter part of December, 1884, Mr. George S. Bowen made a suggestion of calling the electric lighting companies doing business at that time, together, and, with them as a nucleus, to form an organization to be national in its character and modeled after the then existing Gas Association. This suggestion was made to several of those interested in electrical matters in Chicago, and it was finally decided, after many futile discussions, to call a meeting to perfect the necessary plans for such an organization, and a date was decided upon for this meeting. There was but little interest displayed in the matter, however, and so few were present that nothing was accomplished, and it gradually became understood that the proposed plan had fallen through.

In the early part of February, 1885, the subject was again revived, and sufficient interest excited, so that a meeting was held, eight or ten being present. I give the names from memory, and my list may not be entirely correct: Mr. George S. Bowen, Mr. C. C. Warren, Mr. M. A. Knapp, Mr. Wm. A. Hammond, Mr. E. A. Sperry, Mr. D. K. Stiles, Mr. W. A. Kriedler and myself, all of Chicago. At the meeting it was decided to issue invitations for a Convention, to be held in Chicago, and a Committee on Invitation and Arrangements, composed of Messrs. George S. Bowen, E. A. Sperry and myself, was appointed. Of electrical journals, the first to take notice of the National Electric Light Association, and to publish the call for a meeting in Chicago, was the *Electrical Review*, of New York. The only meeting of the Committee on Arrangements was held at the office of the Electrical Supply Company, then located at No. 175 Lake street, Chicago, at which the form of invitation was arranged and at which it was decided to correspond with some of the principal electricians of the country, requesting them to be present if possible, and to read a paper before the Convention. The details incidental to preparing and issuing the invitations, as well as the correspondence in reference to the papers, were left to myself. As there was at that time no directory or list of electric lighting companies, we were obliged to depend on the books of the Electrical Supply Company for our list of names, and, to more fully cover the field, we took, in addition to that list, the cities in the United States with 20,000 inhabitants and over. In many cases we found it necessary to direct our invitations to the "Electric Light Company" that we thought might be located in each of these cities.

We entered into correspondence with Thomas A. Edison, Charles F. Brush and Elihu Thomson, requesting them to attend the Convention, and received replies from all three stating that they would be unable to comply with our request.

About February 18, 1885, a meeting was held at the Grand Pacific Hotel, Chicago, and George S. Bowen was elected temporary chairman, and, afterward, the organization was completed with J. F. Morrison as President.

While during the preliminary work we had much hope and some idea that certain good results would attend a conference of all those interested in electric lighting, we, none of us, of course, realized the extent of the benefit which would ultimately result. At that time each of us was interested in our object of organizing a National Association, as we believed that it would be a good thing, and of mutual benefit to all, and it seemed necessary that some one should start it. What this Association has grown into, the constantly increasing interest excited by the present National Electric Light Association, and its increasing scope of usefulness, can bear witness.

MR. MASON: I rise to make a suggestion, if you will permit me; it is, if any members of the Association have valuable reminiscences, that they put them in writing and hand them to the Secretary, that we may have the benefit of them in the report of our Proceedings; and, secondly, that we adjourn to meet at half past three o'clock.

The motion to adjourn was carried.

AFTERNOON SESSION.

THE PRESIDENT: The Convention will come to order. The following letters have been received:

INVITATIONS.

OFFICE OF PROVIDENCE STEAM ENGINE CO.,

Rathbone Gardner, President. William B. Waterman, Treasurer. F. W. Phillips, Secretary.

PROVIDENCE, R. I., February 18, 1891.

Mr. Marsden J. Perry, President National Electric Light Association.

DEAR SIR: Will you allow us, through you, to extend to the members of the National Electric Light Association a cordial invitation to visit our works and inspect the improved Greene engine in process of construction.

We shall be glad to welcome any member of the Association at any time during their stay in this city.

Yours very respectfully,

Providence Steam Engine Co.,

RATHBONE GARDNER, *Pres.*

PROVIDENCE YOUNG MEN'S CHRISTIAN ASSOCIATION.

H. S. TARBELL, *Pres.* H. J. WELLS, *Treas.*
HAMILTON S. CONANT *Gen. Sec.* H. M. BOSS, *Sec.*

NEW BUILDING,

375 WESTMINSTER, CORNER JACKSON STREET.

PROVIDENCE, R. I., Feb. 18, 1891.

M. J. Perry, Esq., President National Electric Light Association.

DEAR SIR: In behalf of the Providence Young Men's Christian Association, it affords me pleasure to extend to the delegates in attendance at the Convention of the National Electric Light Association in this city an invitation to visit our new building at such time as it may suit your convenience.

The building is open at all hours from 8 A. M. to 9:30 P. M., and visitors will be welcome at any time. If the delegates should see fit to accept this invitation to visit the building in a body, we shall be pleased to make arrangements that will facilitate their seeing it without unnecessary delay.

Respectfully yours,

HAMILTON S. CONANT,

General Secretary.

ELECTRICAL AND INDUSTRIAL EXHIBITION,

AT WORCESTER SKATING RINK, 19 FOSTER STREET,

WORCESTER, MASS., Feb. 14, 1891.

National Electric Light Association.

GENTLEMEN: Being greatly interested in Electricity, and as it is intended to make the above Exhibition of interest, I would most respectfully invite your delegates to visit the Electrical and Industrial Exhibition to be held at Worcester, beginning Monday, February 23d.

Most respectfully yours,

H. H. BIGELOW.

THE PRESIDENT: If there is no other disposition to be made of these communications, they will be received and placed on file.

THE PRESIDENT: The first item on our programme this afternoon is a paper by Prof. Elihu Thomson, on "The Electric Arc and its Use in Lighting." (Applause.)

THE ELECTRIC ARC AND ITS USE IN LIGHTING.

PROF. THOMSON: Mr. President and gentlemen: My object in selecting the title of this paper was to have a brief review and go over the subject of the electric arc, and review some of its important features, particularly as applied to lighting, and, at the same time, to study it in a scientific manner, so far as was possible within the limits of the time. On getting well into the matter, I found that it was a much larger subject than could be handled in a single paper, and, as a consequence, I had to cut a good deal of it short towards the end.

It is curious that, notwithstanding the fact that as a source of illumination the electric arc has been known since the beginning of the century, the scientific study of its nature has been but little pursued. It began to be known as a sort of scientific curiosity, being at first set apart as one of the many phenomena observed in the use of powerful batteries. It was not until about 20 years after its discovery by Sir Humphrey Davy that any proposals were made to use it in lighting, and, subsequently, for many years it was occasionally employed either in lecture demonstrations or in obtaining an intense light for some special purpose.

The efforts to use it in lighthouses led to the designing and construction of machines on the magneto-electric principle to replace the cumbrous and costly batteries otherwise required. I remember vividly the hours of labor and time necessary to prepare a battery of 40 Bunsen cells for use in working a single small arc light for, at most, two or three hours. But I remember far more vividly the suffocating fumes and risk of acid spilling, with accompanying ruin, concomitant on the taking down of a partially exhausted battery. Even to work with the arc for an hour or two was, however, adjudged a sufficient compensation for the disadvantages in obtaining the current. All this has, however, been changed, and the past 10 or 15 years has made the arc as a source of illumination one of the indispensables of a progressive community. Instead of the original little short sticks of wood charcoal used as "points," which were only "points" because it was not expected that the arc would be burned for more than a few minutes without exhausting the battery, there came later on the little hard carbon sticks about two inches long and three-sixteenths of an inch square, sawn from hard gas-retort carbon, or from battery plates; and, lastly, came the moulded and forced carbons made from a paste in a powerful press, millions of which are now required every week to keep the lamps at present in use supplied.

The charcoal points of Davy were touched together horizontally after attachment of the wires to the battery and were then separated. The stream of hot flame which followed or joined the points, being deflected by air currents, took the form of an arch or curve, which gave the name to the phenomenon. Even with one carbon directly over the other, the curved form of the stream is the rule when the carbons are widely separated. Davy's original experiment was made with a battery of

2,000 cells, with zinc and copper plates about six inches square, the exciting fluid being very dilute sulphuric and nitric acids.

Davy's description is as follows: "When pieces of charcoal about one inch long and one-sixth of an inch in diameter were brought near each other (within the thirtieth or fortieth part of an inch), a bright spark was produced, and more than half the volume of the charcoal became ignited to whiteness; and, by withdrawing the points from each other, a constant discharge took place through the heated air in a space equal at least to four inches, producing a most brilliant ascending arch of light, broad and conical in form in the middle." This was evidently a long, flaming and horizontal arc. I find this form shown in a book published as late as 1846: Davis' Manual of Magnetism. Indeed, I know of no more forcible example of the persistency of old ideas than is afforded by the accounts given in the books concerning the nature of the electric arc. The persistence of old cuts is also equally exemplified, even down to the latest publications, giving pictures of the electric arc. The carbons are generally shown crusted over with dense masses of impurities melted into globules and adhering to their sides (Fig. 1). Such figures would not now be recognized as resembling arcs formed with good, pure carbons, such as must be used for commercial results in arc work.

Figs. 2 to 4, inclusive, show the development, at least in illustration, concerning the electric arc.

Fig. 2 is from Davis' Manual, referred to.

Fig. 3 is one of the figures showing the arc, taken from Ganot's Physics, published in 1863, though the figure is from the seventh edition, 1886. It is virtually the former figure made vertical.

Fig. 4 is a figure of a modern arc.

In regard to the ideas put forward as to the nature of the electric arc, there is even a wider divergence than in the figures used for representing it. But these views are remarkable for their general inaccuracy or crudity, and evidently have been handed down with modifications. Few of those who have written about the electric arc, at least in text-books, seem to have had the courage to look at the arc, or they may have seen it "through a glass darkly, and not face to face." It would require too many and lengthy quotations to give these various views. In most of them the light of the arc is attributed to intensely heated carbon particles transported by the current from one pole to the other. In most of them the idea of carbon vapor as a possible factor never seems to have arisen. Others attribute the arc to the heated air between the carbons, which carries carbon particles, some of which are burned.

The following quotation from a book on electric lighting, published in 1884, is a type of many such accounts:

"In arc lamps, as we have already stated, the resistance which converts the current into heat is that of the heated air between the ends of two carbon rods, from one to the other of which the current passes. The light is produced by the incandescence of the ends of the carbon poles, and of the minute particles of carbon, which become detached and float in the heated air between them. The heated air containing the particles of carbon forms what is called the electric arc."

Here the heated air and carbon particles, floating therein, are definitely stated to form the "electric arc." Nothing is said of carbon vapor having anything to do with it.

Even the statement that the positive carbon burns twice as fast as the negative is very frequently found unqualified in any way whatever. The experience of the lamp trimmer is, I need scarcely say, not in accordance therewith, the fact being that the rate of consumption, even in direct current arcs with the same size carbon in both holders, varied sometimes quite widely from the proportions stated. However, we shall make better progress if we discard at once the older notions, and, adhering only to that modicum of truth which often accompanies error, supplant the error by the results of our own observations and experiments. My endeavor will, therefore, be to state as briefly as I can such views of the nature of the electric arc as seem to be borne out by observation during many years, and under greatly varying conditions of its production.

Let an attempt be made to separate any part of a circuit in which the current is maintained by a sufficient electromotive force or potential, and we find that if the separated ends are moved quickly we get a flash or spark of varying length which becomes a flame of great heating effect if the current be of large rate of flow. If the separation of the two parts of the circuit be made slowly, a continuous flame or discharge will take place between the ends, if they be not too widely separated or not so widely separated that the potential or pressure of the current is insufficient to force current across the space. With considerable potentials and heavy currents a space of many inches may thus be bridged. Whether the separated ends be of iron, copper, carbon, platinum, zinc or other conductor, the hot discharge is still formed. Therefore, while the electric arc is generally spoken of as that flux occurring between *carbon* ends separated, of course, it cannot be so limited, and we frequently, therefore, refer to copper arcs, iron arcs, carbon arcs, to distinguish one from the other. What, then, is the arc so formed? Is it heated air between the ends separated, containing detached particles of the conductor in process of carriage, as was apparently thought for a long time to be the case? No, the arc proper is composed of a stream of vapor rising from the actual boiling or vaporization of the solid or fused ends of the separated conductors. In so far as the surrounding air mixes or combines with this vapor stream it is modified by the presence of oxygen and nitrogen, but the air or any other gas is not essential to be present and is merely incidental to the formation of the true arc stream in air. Indeed, it may seem strange to some to speak of vapor of carbon, copper, iron, platinum, etc., but their production is merely a question of temperature in any case. In the electric arc there is a real distillation of the conductors forming it and this accounts for the variation of color and temperature to be found in different arcs. The copper arc evolves a peculiar green light which is exceedingly trying to the eyes, as those who have experienced its effects well know. Zinc gives a whitish blue, while the carbon arc proper is purplish in tint. The arcs from various metals give in the spectroscope the characteristic lines of the vapor of each metal.

As a curious incident, showing the presence of the metal vapor in the arc, I may mention the fact that when by accident a person has had a portion of his clothing bathed for an instant in a heavy copper arc, caused by a short circuit of heavy current mains, there has been found a considerable deposit of copper, enough, in some cases, to give the reddish color of copper to the surface bathed, which, if moistened, turns green by oxidation. It also gives a deep blue to dilute ammonia in which it is washed, thus showing the presence of copper. In like manner these metallic arcs will give a deposit of the metal on cold surfaces which they touch.

It appears to be the positive pole which gives out the vapor stream. With carbon the positive vaporizes steadily and is consumed much faster than the negative. In the use of the arc, however, for lighting we have learned to distinguish between what is called a "short arc" and a "long arc" system. In "short arc" systems the carbons are burned much nearer together than in the "long arc" systems. Let us suppose the case of two carbons touching each other, with a current passing, and then that we very slowly separate them, stopping to observe effects. When the contact is light before actual separation, a visible heating of the meeting ends is seen. On attaining a small separation the space between seems filled with hot vapor and we have a short arc where the separation is perhaps not over two to three one-hundredths of an inch. There is also noticed an active transfer of carbon from the flattened end of the positive and a deposition of carbon on the end of the negative carbon. This deposited carbon takes the form of a mushroom end after a time, and breaks off. Meanwhile, combustion goes on at both poles and wears away the sides of the positive carbon while the transfer of carbon wears away its tip or crater. The burning also wears away the negative at the sides, while the tip is built up by the mushroom deposit from the arc. But the cutting in of the negative finally severs the mushroom tip and it falls away. Hence, both carbons are eventually consumed. To develop a short arc there is required a little over half the potential that is needed for a long arc, or about 25 volts, more or less, and, therefore, to give out equal heat energy in the arc, the current must be double in the short arc over what it would be in the long arc. The short arc is subject to the objection of a continual frying sound emitted and great variations of luminosity; it requires a very dense and hard carbon to conduct the current without great loss, and involves line loss of at least four times the amount with the long arc if equal gauge wires be used.

In fact, while in the past such arcs were common, their number is diminishing, as they are being replaced by the more efficient and completely developed arcs called "long arcs," which are so called to distinguish them from the "short arcs." Returning to our separating carbons, we find that as the space of the arc is lengthened from the "short arc" condition, we pass a stage of great flickering and unsteadiness and a fluctuating potential between the carbons, and then reach the stage of production of the "long" or quiet arc. With ten amperes the separation may now be about one-sixteenth to one-tenth inch or more. Smaller currents require less separation and larger ones an increased separation. At this stage the arc is quiet, with good pure carbons very steady, and the potential difference remains at about 45 volts, if, of course, the carbon is properly fed to make up for combustion. The perfect arc is really a beautiful phenomenon. While the positive carbon still loses by volatilization from its tip or crater and by combustion from its sides, the negative gains no deposit, but wastes at a less rate than the other, and by combustion only. The carbon vapor carried off from the positive is consumed by the oxygen of the air before it can deposit on the negative. . Hence, the outer zone of flame, which can easily be distinguished from the central zone or arc flux proper, is probably a zone of combustion similar to that existing in ordinary flames. The removal of carbon by vaporization from the positive end gives rise to the crater or cup which is so prominent a feature of carbon arcs produced by continuous currents. The size or area of the crater is a rough measure of current strength, but varies with different qualities of carbon. With very long arcs the crater, or hollowed end, disappears and the ends become rounded. A well formed crater, with the arc or flame confined thereto, means usually a steady light, since the chief source of light in an electric arc is from the positive crater, which shines like a diminutive sun and represents the hottest part of the arc. The vapor light proper, or flame light, is comparatively very feeble and of a purple quality in air. Hence, the arc light is as truly an incandescent source of light as is the incandescent carbon filament, with the difference that to run the latter at the temperature of vaporization or boiling point of carbon, so to speak, means instant destruction, while by the necessities of the case the light obtained from the arc is chiefly that emitted from a surface of carbon at its temperature of boiling, or, more correctly, of sublimation at atmospheric pressures. This temperature is exceedingly high, and accounts for the well-known superior economy in light production of the arc over all other kinds of lighting. The temperature of the positive carbon crater is so high that the carbon exists there in a soft or plastic condition capable of receiving an impression like putty. I have proved this with very large arcs of 150 to 200 amperes by suddenly forcing the carbons together when the current had been cut off, and finding that they would fit each other perfectly, the negative impressing its form on the positive crater.

As an interesting fact in this connection, I may state that I have been able to bend carbon sticks three-sixteenths to one-quarter inch in diameter, by passing current through them of sufficient amount to almost vaporize the sticks and cause them to emit an intensity of light approaching that of the arc.

These facts would point to the possible fusion of carbon into liquid carbon at arc temperature under a high pressure of inert gas. No one has yet seen carbon in this liquid condition, and the electric arc alone has made us acquainted with carbon vapor. One cannot fail to be impressed with the fact that the conveyance of carbon in the arc has a striking resemblance to a plating process, where metal is taken up by the bath from the positive plate and deposited on the negative. In the arc, the hot vapor stream or flame takes part of the bath and probably acts by molecular interchanges of carbon atoms in molecules of carbon to cause the transfer which occurs, just as in the plating bath the molecules of the plating compound are polarized and allowed atomic interchange which results in conveyance of metal through the bath.

Another curious fact in relation to the arc is the distribution of potential in it. Dr. J. A. Fleming has recently shown that the difference of potential between the positive carbon and the arc flame is about 40 volts, aud the few volts which express the difference between the flame and the negative make up the total potential, say, 45 volts. Hence, the real work of the arc is not in the flame; the energy is not used in overcoming flame resistance, but chiefly in vaporizing carbon in the positive crater. It is certainly not strange that with 40 volts and, say, 10 amperes, or 400 watts expended virtually at the crater surface of the positive carbon, the temperature and luminous effects should there be so great.

The distribution of potential in the arc just noted was also brought out about the year 1884, in some testimony in an interference in our patent office, concerning an arc lamp cut-out which I had invented, and which took advantage of the potential differences between the carbons and the arc flame to cut out the lamp when the arc was too long. It is, of course, well known that the value of an arc light for general illumination is greatly enhanced by the fact of the distribution of light being mainly in a downward direction in continuous current arcs. This, of course, follows from the fact of the positive carbon crater being above, such crater being the part from which most of the light comes.

This matter has been quite thoroughly investigated, and many diagrams of distribution are to be found in the literature of the subject, as published from time to time. They show that with the long arc the maximum intensity of light is from 40 degrees to 60 degrees downward from the horizontal, and that the horizontal intensity is generally much less than one-half as great, while, of course, the intensity diminishes above the horizontal direction, and ultimately becomes zero before reaching the upward vertical direction. In like manner, the approach to the downward vertical from the direction of maximum intensity is attended with similar rapid diminution.

The spherical candle power of arc lights would, therefore, be only a fraction of the rated candle power which is generally taken at the maximum light obtainable in the best direction from the particular arc or kind of arc in question.

For this reason the term 2,000 candle power arc has little significance as indicating the illuminating power of an arc. It is a convention only, and a poor one at that. It is now generally taken to mean an arc with 10 amperes and not less than 45 volts potential difference between the carbons, or a 450 watt arc. The quality of the carbons will determine whether the 450 watts will be expended in obtaining the most light or not, or whether that light will have a maximum intensity at one angle or another within certain limits.

When arcs are operated on by alternating currents, the effects mentioned are only partially exhibited, and the phenomena of the crater are, of course, masked or obliterated on account of reversal of function of the carbons. Unless the alternations are rapid such arcs are liable to extinction at the zero points of current, particularly when run in a draft of air. A strong draft of air or a displacing magnetic field may, of course, so disturb an arc as to cause its extinguishment.

In the early years of the growth of arc lighting as a means of illumination, the effects obtained were not of the best. Unsteadiness was the rule, and it required much persistent effort to discover the causes and find the remedy.

The prominent defects were, and, we may add, are still, hissing, sputtering, flaming and general unsteadiness. Hissing or frying comes, of course, with too short an arc, and may be connected with too vigorous vaporization. They may also be due in some cases to a carbon of too coarse a grain. Sputtering may arise from impurities in the carbons, and flaming from too long arcs, from impure carbons, or from carbons insufficiently baked and containing unexpelled gases. Running an arc at a length between the long arc condition and the short arc condition may cause great unsteadiness of light. There is, in fact, a critical point in the length, below which there is a considerable fall of luminosity and a drop of nearly one-third of potential. As an arc lengthens by combustion of its carbons beginning below this critical point, great unsteadiness will be manifest on arriving at the critical state and a little longer arc brings about a sudden and very marked increase of potential, of illumination and of steadiness.

An observer may easily detect these conditions without special effort. The earlier carbons used with arc lamps in the United States were both badly conducting, impure, and badly made. Copper coating was a necessity. French or Carré carbons were much better, but were too costly to import. The use of the petroleum carbon, or the carbon obtained by the carbonization of the tarry residue left in the distillation of crude oil, made a wonderful difference in the purity of the carbons, and improved machinery gave accuracy of form and cheapness. To one familiar with the former cost of carbons for battery arcs the reductions in cost are very striking; carbons three-sixteenths inch square cost a number of cents an inch before the year 1878.

Another important matter in relation to carbons is that the size of section or diameter must be proportioned to the current used. Where attempts have been made to prolong the hours of burning of a carbon by enlarging its diameter beyond certain limits, they have resulted in injury to the character and distribution of the light. Large diameters of carbon may burn too blunt to let the light out between them.

Likewise, where attempts have been made to prolong the hours of use by employing a harder or denser carbon than before, it has frequently been found that a sacrifice of light has been incurred, rendering the results much less satisfactory.

One of the chief obstacles to the employment of quite small arcs with currents of three or four amperes is the difficulty of obtaining suitably uniform carbons.

Arcs of even as low as two amperes at 45 volts are easily produced, and such small arcs might even have commercial utility if the difficulties in relation to carbons were removed. An arc consuming 90 to 100 watts means, of course, about seven to eight to the electrical horse power.

On the other hand, very large or heavy current arcs are difficult to control. They are apt to be unstable at times, and when they get to hissing, or rather roaring, it is difficult to restore quietness and steady action. The introduction of cored carbons for the positive, has, however, done much to remedy the difficulty, and, indeed, to render it possible to obtain very uniform results from arcs in general, wherever such results are indispensable. The introduction of the central soft core into the carbon seems to locate the arc centrally, hold it from fluttering or shifting its position on the end of the positive; in other words, the core fixes the position of the crater, and so benefits the light.

It follows, from the fact that the voltage required to sustain an arc with large or small currents ranges about 45 to 50 volts, that the larger the current passing in an arc, the less its electrical resistance. Hence, well developed arcs with four amperes will have about 11 ohms, with 10 amperes 4.5 ohms resistance and with 100 amperes .45 ohms. This fall of resistance with increasing current is easily explained by the broadening or thickening of the arc stream, and the widening of the crater on the positive carbon. This widening of the crater also gives increased illuminating power without increase of temperature. It is probable that the actual crater temperature is as great in the small arcs as in the large ones. In fact, this is implied by the quality of the light remaining the same. Nevertheless, the larger the arc the greater the economy or the greater light giving power per unit of energy. This would naturally be expected, as the concentration of heat, and lessened chances for escape of heat by convection and conduction, would conduce to that result.

The fall of resistance with increase of current has an important bearing on the construction of dynamos for arc lighting and the running of lamps on constant potential or incandescent circuits, and will be referred to later on. Attempts have been made at various times to save carbons in arcs by excluding the oxygen of the air, which is the cause of their waste or consumption by burning. The gain has not apparently compensated for the disadvantages incurred, particularly as the total exclusion of oxygen means that the carbons become blunt. They would be prevented from pointing themselves or acquiring tapered ends by burning, a condition essential to good working and distribution of light. Even when the arc is formed in a vacuum the carbons, though not burned, are slowly consumed, and carbon deposited as a soot on the sides of the vacuum chamber, an effect consequent upon the vaporized carbon in the arc being carried off and condensed again as soon as the vapor escapes the heat of the arc stream.

In fact, I have found it possible to coat objects on the inside of a bulb with silver or other metals volatilized suddenly by arcs in vacuo, and have obtained in some cases coherent brilliant deposits. The metal is raised in vapor as a metallic arc and distills and condenses on the surfaces near at hand.

Before passing to the consideration of the running of arc lamps in series, or in multiple, and the condition to be fulfilled in each case, we may state that although in ordinary cases an arc is formed by a single pair of electrodes or carbons, and by a single circuit current, compound arcs, or arcs produced by combinations of two or more currents, with three or more electrodes, are possible. I am not aware that any others than myself have experimented in this direction. I have, however, produced lights with two positives and one negative, with one positive carbon or crater and two, three, or more negatives, and with two positives and two negatives. I have caused arcs to cross each other, as when four carbons are used, pointing towards a center, the two pairs opposite being, respectively, connected with different circuits. In this way direct arcs have been, as it were, mixed with alternating arcs and a curious compound effect produced by crossing two arcs made with two alternating currents, the waves of which are displaced in phase. Without going fully into these experiments, I will present figures showing two good examples. Fig. 5 is formed by two currents sent into a positive *P*, and dividing, after passing the crater, into two streams going to the two negatives. In this case the positive crater is fully exposed horizontally and gives a most intense light in a direction forward. Such an arc is well adapted for projection by mirrors or lenses.

Fig. 6 shows the arc formed by crossing two alternating currents out of phase. In this case there is at successive times an exchange of current between all four carbons in varying directions, so that the arc flame becomes, as it were, a ball or disc of very hot flame supported by the four carbons. These experiments have not been fully described as yet, owing to the lack of time, but they show very well that, even when we have fully studied the single, simple arc, we will not then have exhausted the subject, as these compound arcs may be varied in character to a great extent, and present new effects.

In regard to that portion of our subject which concerns the use of the electric arc for lighting, it is true that there is a wide field before us. I cannot hope to do more in this paper than to outline, in addition to the considerations already alluded to, some of the other prominent features of the subject. It is well known that by far the larger proportion of electric arc lights in operation are run on circuits of constant current, the lights being in series.

If arc lamps be connected in parallel, as on low potential incandescent mains, special devices are required to keep the current supplied to each lamp at the right amount.

It may appear at first to one who has not had occasion to closely study these matters that, given a constant potential circuit of 50 volts, arc lamps requiring 50 volts could be connected in multiple or parallel without difficulty. The fact is, however, that the condition of electric arcs, being supplied with a constant potential, involves a theoretical impossibility. Theoretically, such an arc would take an infinite current and energy. Practically, the current in an arc with constant potential becomes very heavy, and if the carbons be separated to cut the current down, as by a lamp magnet mechanism, a condition of fluctuation and instability results. This is a direct consequence of the fact before stated, that the resistance of an arc is not like a wire resistance, but falls with increase of current, and *vice versa.* For stability, the resistance should not be dependent wholly on the current passing. To remedy the instability a resistance, known as a "choking coil" or "sluggishing coil," is inserted in the arc branch and the potential raised, say, to 65 or 70 volts. Under these conditions, that is, with a resistance taking up 15 to 20 volts, in series with the arc, it may be run in multiple with incandescent lamps or with other arcs. There is, however, a waste of energy equal to the product of the current strength by the loss of potential, 15 to 20 volts, in the resistance. A great deal of useless experimenting has been, and probably is yet, carried on with the vain endeavor of getting rid of the resistance or choking coil in this case, but the difficulty is inherent in the nature of the arc, the relation of resistance to current giving rise to instability of current in the arc.

Similarly, not all dynamos, even if of sufficient potential, will run arc lamps in series. Arc machines require special properties, or the current will be unstable and the light will fluctuate or "surge," as we sometimes call it, possibly to an extent amounting to extinction and relightings, occurring at short periods apart. This action, like the other, is dependent on the relation of current and resistance as inherent in electric arcs, and the series of lights would, in each case, require dead resistance up to a certain amount in circuit to render the current stable. Then, whether a series be operated or a single arc be operated, either a dead resistance must exist in circuit or the current supplying apparatus must have special properties. The arcs produced from batteries were stable because the resistance of the battery itself was sufficient to ensure this. Arcs are not stable as fed from accumulators of very low internal resistance unless the arc is one of enormous current.

Briefly, the property required to be possessed by an arc dynamo is that as its current rises above the normal the electromotive force must fall, and as the current diminishes to a little below the normal the electromotive force of the dynamo must rise. It is not sufficient to secure this changing electromotive force by regulators, as they are generally behind time for causing stability of current, however well they may operate to regulate for varying numbers of arcs in the series to be supplied.

The properties of dynamos are sometimes expressed by what are called "characteristics," or "characteristic curves," obtained, for example, by laying off vertically, or on the ordinates, the electromotive forces corresponding to varying currents given out by a machine, which currents are laid off horizontally, or as abscissæ. In arc machines the curve so produced is convex upward and droops at its outer end *b*, Fig. 7. Assuming normal current at 10 amperes and an electromotive force of 500 volts, at 11 amperes the electromotive force may have changing the field magnet strength by automatic mechanism, weakening the field when lamps are cut out and strengthening it when lamps are added to the circuit. Another means of regulation is the rotation of the commutator or brushes so as to take current from positions corresponding to increased or decreased electromotive force in such a way that the current obtained is constant, The former method first appeared in the Brush arc apparatus, and the automatic commutator brush movement in the Thomson-Houston machines. The latter method renders the machine completely automatic under variations of load, while in the former there still is required a manual spark adjustment in the brushes as the field magnet is altered in force under different loads. The two methods were subsequently combined by the writer in conjunction with Mr. E. W. Rice, Jr., in such a way that the necessary brush adjustments were made automatically at the same time with the variations of the field under different loads. This combined method has been used for some time past in the Excelsior machine constructed under the patents and designs of Mr. Hochhausen, whose name is so well known in connection with arc lighting and plating and other electric apparatus in this country. On account of the fact that with the addition of arc lights in a series a higher and higher potential difference is required at the terminals of the dynamo, it becomes a question how far this increase may properly be carried. It is not unusual in the present practice to run from 50 to 60 lights in a series, each demanding from 45 to 50 volts, or a total of, say, 3,000 volts. In going beyond this amount the difficulties of insulation are greatly increased, as well as the dangers of high potentials, while the consequent risk of breakdowns resulting from failure of insulation or leakage are often sufficient to offset any saving of wire conductor that might be obtained by running more lights in series. Instances have occurred in which, with ordinary wiring and precautions, 120 to 150 arcs have been run for days together, but such a practice is to be condemned as involving hazard of all kinds.

It has been supposed by some electricians that there existed a peculiar fitness for arc lighting in series in dynamos of the open coil type, such as the Brush or Thomson-Houston, over those of the closed coil type, such as the Gramme or Siemens forms. Whilst, personally, I have never been prepared to admit this peculiar fitness, constructors of machines of the closed coil types have certainly succeeded in removing any doubts on that score. Mr. J. J. Wood has, in building his form of Gramme machine up to the highest capacities for series work, taken a leading position in this respect. In fact, the simplicity of the commutator and the ease of insulation of machines of the open coil type undoubtedly rendered them more capable of retaining insulation at high potentials than the early commutators with numerous segments used on Gramme and Siemens machines, as such commutators were first constructed. Likewise, improved methods of insulation and winding have gone far to put both types of machine far in advance of what they were formerly. While on this subject of arc machines, it may be well to say a few words as to the action of flashing, which can occur in all machines of high potential under certain conditions. In the first place, the term flashing, as here used, is not intended to refer to sparking at the commutator, but rather to a flash or continued spark carried over during revolution of the armature from one brush towards the other, either all around the commutator or part way only. This action occurs when any two successive segments in the commutator continue their discharge, one towards the other, over the insulating space between them during a considerable part of the revolution. An arc forms in the slots or between segments and moves with them. This action, while not very damaging where the segments are massive and insulated with air spaces, is more serious with insulation filling between the segments, as it is apt to cause a burning out, and either short circuits the armature coil sections by connecting the segments, or seriously roughens the edges of the segments and the face of the commutator.

Bad setting of brushes may cause sparking as well as flashing; and dirt, in some cases, or too much oil, may cause it. Slipping of belts or sudden fluctuations of speed may also provoke it. Or a machine, overloaded, may flash by an opening of the circuit due to too many lamps, the electromotive force required for which number the machine cannot maintain. The presence in a circuit of one or more lamps which do not feed properly may cause momentary cessations of current and flashing to occur, especially when the machine is carrying its full load. With all arc circuits there should, of course, be a surplusage of capacity in the dynamo, *i. e.*, the machine should not be run to the limit of its electromotive force. It has become customary with the best makers to so rate this capacity that there will always be a margin of excess to meet contingencies. The line resistance may, of course, be, in the case of long circuits, such as to cut down to a considerable extent the working capacity or number of lamps in series which can be run from the dynamo, and due allowance should always be made for this resistance in estimating the true capacity. Instances are not uncommon in which by improving the contacts of switches, hangers, joints, etc., a gain of two or three lamps may be made in circuits of 50 or more lamps in series. An improvement in the insulation of a line will often have a similar effect in adding to the apparent capacity.

I had intended at the outset of this paper to discuss in a general way the question of the different types or classes of lamps used for arc lighting. It is a department of the subject which is of considerable importance, but I find that the paper has become too long already, and for the present I will simply allude to one or two general features. Concerning the manner of feeding the carbons, the mechanisms in use may roughly be divided into clutch and gear mechanisms. Among clutch mechanisms we find certain well known forms, while the gear mechanisms best known are of the escapement order. Both types have undergone many modifications, and combinations of the two exist.

Whether one or the other type is to be selected will depend largely on the conditions of use, assuming both to be equally well constructed and kept clean. Into these questions, however, we cannot now enter.

Arc lamps may also be divided according to the way in which the magnet system acts to control the feed of the carbon. Before arc lamps were run in series it was sufficient to have the controlling magnet in the main circuit and this was the case in almost all the older forms of lamps. The Lacassagne & Thiers lamp of 1856 was a notable exception in that the control of the feed was differential, or dependent on the difference of power between a main circuit coil and a high resistance shunt circuit around the arc.

I have, in fact, made an exact reproduction of the Lacassagne & Thiers lamp, according to their patent specification, and have found that its action is perfect when used in series with other lamps, except that it requires to be helped to separate its carbons. If the carbons are quite pointed at the start even this is unnecessary, as the points soon heat and burn away and form the arc. The feeding depends on the flow of mercury through a small valve, which is adjusted by the differential magnet system, and the feeding is so continuous and imperceptible that the arc is beautifully steady and constant in length.

At the present time the differential lamp magnet system is of several kinds, according to the relative disposition of the main and shunt coils.

In the commercial Brush arc lamp they are disposed one over the other on the same axis and affecting the same magnetic cores. The only objection to this disposition, which has the advantage of simplicity, is that the shunt circuit can never act positively to feed the carbons or release the clutch or gear, but can only weaken the effect of the main coil or overpower its lifting or separating action on the carbons.

Other forms of differential lamp embody two circuits acting on separate magnets pulling in opposite directions, the main circuit to separate the carbons and the shunt to feed them. In this case the action of the shunt is more definite and positive, as it is not limited simply to overcoming the force of the direct or the main magnet.

A third arrangement involves the application of the repulsive action of the two coils, as when the direct coil is wound on a fixed magnet, and the other, or shunt, upon the feed controlling armature therefor and tending to cause repulsion of the armature from the main magnet. This arrangement is both simple and positive in its action.

The differential types of lamp act well when the circuit current is kept constant and require re-adjustment generally for each change of current strength by which they may be operated. Hence, if a portion of a line be leaky the lights are apt to burn badly, owing to diminished current, while the dynamo may be furnishing full current. Of course, such a line ought to be condemned and its insulation improved. Nevertheless, I have frequently seen lights suffer from leakage on extended circuits in cities, especially in very wet weather. This is a state of things which the line superintendent can do more than any one else to correct, by attending to the correct disposition of the wiring, and its character as regards leaks.

The type of arc lamp in which the shunt magnet alone controls the feed of the carbons is not sensitive to slight variations of current, but maintains a full quiet arc with the current it gets. This is because the main current is not concerned in the feeding action, but the action is solely dependent on the potential difference of the carbons. Hence, its behavior is, on the whole, more uniform than the differential type, and, within limits, it does not require re-adjustment for different current strengths.

This principle has been extensively introduced in the Thomson–Rice lamp of the Thomson–Houston Company. In this lamp the carbons are separate at the start and are brought together on the first passage of the current, after which they separate solely under the influence of the shunt circuit magnet and the feed is likewise controlled thereby. The carbons in these lamps are not so apt to slide by, or alongside, each other by jarring when no current is on the lamp, as may occur, particularly with careless trimming, in those lamps in which the full weight of the upper holder and carbon must be borne by the under carbon when the lamp is not lighted. .

Arc lamps have been made with many variations in the magnetic arrangements controlling the carbons, a brief statement of some of which is as follows :

Carbons lifted or separated by direct or main magnet;

shunt magnet acting on a variable resistance to cut out the main magnet in feeding.

Carbons lifted by main magnet as before; shunt acting to put the main magnet (made movable) into position for feeding.

Carbons separated by main magnet armature; shunt circuit magnet acting to divert or shunt the magnetism of the main magnet from its armature.

Carbons separated by main magnet; shunt acting to free the carbon holder independently of the support given by the main magnet.

Carbons separated by a spring and allowed to act by the main magnet lifting a weight which otherwise holds the spring from acting; shunt magnet acts against the spring to feed and regulate length of arc.

One carbon, generally the lower, separated by main magnet, while the other holder is released for feeding only, such feeding being under the control either of a differential system or a shunt magnet only.

Carbons separated by main magnet which lifts the shunt and its armature together, while the shunt magnet armature, acting on the feeding mechanism, controls the arc and feed of the carbons.

Carbon feeding mechanism independently attached to main magnet armature and to shunt armature, so as to receive opposite movements of separation and feed from each, respectively.

Carbons separated by a feeding mechanism moved by the main magnet, and fed by a further movement of said mechanism, causing release or return of same under the accumulated force of both shunt and main magnets acting in the same direction.

Differential clock gear for separation and feed of carbons under control of the regulating system, either simple or differential. Some of the older clock-work lamps embodied this principle.

Carbons controlled by armature of a small electric motor under control of a differential field which turns the armature in one direction for separating, and in the other, or reversed, direction for feeding the carbons. Tchikoleff's early lamp was of this type.

Carbons controlled by a motor running at a certain speed when the arc is of normal length, and varying in speed when the arc is too short or too long, combined with a centrifugal governor on the shaft of the motor acting on variations of speed to gear motor shaft to screw carbons together or apart, as needed, to maintain the normal arc. This mechanism has been applied by me to large arc lamps, such as naval search-lights, and has the advantage of great positiveness and an ability to handle heavy mechanism.

There are also a considerable number of modifications from these principles stated, which cannot be referred to here.

Another excellent mechanism, and one of the most powerful and positive in feeding the carbon, embodies a main magnet separating the carbons and striking the arc, and an intermittently acting shunt magnet for working a pawl which by a suitable gearing, forces the feeding action or approach of the carbons as required. I have used an endless screw gearing with the pawl acting on a rachet wheel to turn the screw, the worm wheel being on a shaft carrying a pinion meshing into a rack on the carbon rod. The worm wheel gearing is lifted by the main magnet to strike the arc, and the shunt magnet in operating its pawl breaks its own circuit and repeats its feeding action as often as may be necessary.

It is interesting to note in this connection that I have built such lamps in which each feeding movement of the carbon is not over one-five-thousandth of an inch and that if the upper carbon rod is held in a vise the mechanism will lift the whole lamp of about 20 pounds weight in feeding, so positive is the action. At the same time, the length of the arc is maintained constant at all times. With so slight and yet positive a feeding action the feed takes place almost continuously.

In the foregoing brief review many matters have been simply touched upon which might readily have been singly expanded into a paper as long as the present one. Material enough now certainly exists, and could be collected, for making a good technical work dealing with the science and practice of arc lighting. My purpose will have been fulfilled if I have succeeded in the present paper in adding some things of interest and instruction concerning this general subject from the standpoint of one who has constructed very many forms of apparatus for arc work, and who has had a continuous and growing experience with such work, from its beginning up to the present great commercial expansion.

THE PRESIDENT: This is a very interesting paper to which we have just listened. Are there any remarks?

Mr. M. M. GARVER, of Newark: I have listened with a great deal of pleasure to the able paper by Professor Thomson, and especially in regard to the view that the arc is constituted of incandescent carbon vapor. It may be of interest to this Association to know that we have from purely theoretical means a clue to the temperature of the carbon vapor. We have no direct means of measuring it. About ten years ago, in studying the subject of the generation of water-gas, I came across a clue of this character. There are two compounds of carbon in the form of a gas, containing different amounts of carbon. In one the carbon is totally consumed. In the other it is partially consumed.

By taking account of the different heating capacities of the two gases, as determined by the galvanometer power of pure carbon and the gas which is but partially consumed, divided by the specific gravity of the gas, we get in the neighborhood of ten or twelve thousand degrees of Fahrenheit for the vaporization of carbon. This, of course, is assuming that the specific heat of carbon is the same at the higher temperature as at the lower, and takes no account of testing through the liquid state.

THE PRESIDENT: If there are no further remarks, we will proceed to the next order of business.

THE PRESIDENT: We will now listen to the report of the Committee on the Proper Lighting Power of Incandescent Lamps—Dr. Louis Bell, Chairman.

PROPER LIGHTING POWER OF INCANDESCENT LAMPS.

DR. BELL: Mr. President and Gentlemen: Your Committee had not proceeded very far in the investigation of its topic before it discovered that the topic was growing, and growing with a prodigious rapidity, so that we have been able to formulate, so to speak, only a partial report, a report that necessarily must leave untouched many things we would have wished to touch, but which we hope embodies certain suggestions that may be of interest to those who have occasion to use incandescent lamps.

In the first place, the necessity for some legitimate rating of the candle power of incandescent lamps becomes evident in the experience of nearly every central station manager who is enterprising enough to keep track of the lamps he is using. At the last Convention of this Association your President gave some admirable samples of the way in which the candle power of alleged 16 candle power lamps varied anywhere from 16 to 18. Now, evidently it is both for the interest of the central station man and of the consumer that each should know exactly what is intended by a 16 candle power globe. It should not be left to the choice of the lamp manufacturer to make any sort of incandescent lamp he fancies and label it 16 candle power. There have been improvements in this direction, as every central station man knows, although the manufacture of incandescent lamps has been very much improved, as we all know.

Now, the questions that came up were about as follows: How should we classify the power of incandescent lamps at all? Shall we classify it entirely by the candle power; or, if not the candle power, to what standard shall we refer the light? Shall we classify it by what is consumed, with specifications for efficiency, or by the watts consumed by the specifications, and the candle power, which give themselves the limitation of efficiency? After a considerable amount of deliberation —aided, I am glad to say, by consultations with a large number of gentlemen who are practical experts in incandescent lamp matters—your Committee came to the conclusion that the last mentioned method of classification was the simplest one to enforce; that is, incandescent lamps should be classified by the watts consumed, the actual power for which the consumer pays; but with the specification as to candle power that limits the efficiency of the lamp to practical values. By practical values I mean such as will not, on the one hand, produce an inordinate waste of energy, or, on the other hand, force a lamp far above its proper candle power and, consequently, burn it out. The interest of the lamp manufacturer evidently lies toward greater efficiency, because, by producing a very efficient lamp, one which will give a large candle power on a small consumption of watts, he is enabled, in the first place, to give a fine, brilliant light, satisfy consumers, and, in the second place, to point with some pride to a reality of power. Unfortunately, when this tendency is carried beyond a certain point, as every practical man knows, the life of the lamp is enormously shortened. A lamp which will burn for 1,000 or 1,500 hours at a moderate efficiency, if forced to a very high efficiency, will burn a very much shorter time.

Now, having determined the proper way, in general, of classifying incandescent lamps, then arose the all important question of the proper limits to be set. We have been so long used to speaking of and dealing in 16 candle power lamps that it seemed inadvisable to abandon that standard. Given, then, the proposition that we are to have a 16 candle power lamp—a candle power that has been sanctioned by very long use—what do we mean by that 16 candle power? Do we mean that the lamp shall give 16 candle power in a determined direction? 16 candle power means horizontal illumination, or what? Inasmuch as the horizontal illuminosity is that with which we have to do in these cases, your Committee was emphatically of the opinion that the mean horizontal candle power should be specified, in other words, that the normal 16 candle power limit should give 16 candle power, taking the average of the horizontal illumination.

Next came the question of practical limits within which the candle power might be allowed to vary. Of course, if we tie ourselves down to a candle power of mean horizontal intensity, we will be establishing a standard which no lamp manufacturer could approach. In other words, it would be commercially impracticable to make a large number of lamps at a low price and have the candle power of each one exactly the same—certain limits have to be set.

Taking the lamps as they are, we find, in actual practice, we have to set those limits possibly seven or eight, possibly six limits, on each side of the 16 candle power. Those limits your Committee found to be entirely too wide, and therefore it entered into consultation with lamp makers for the purpose of finding how close to 16 candle power the limits could be set and yet leave the manufacturer a simple and practical process. The result of this deliberation was to settle upon about one candle power on either side of 16, as, on the one hand, the largest variation which we cared to admit in defining a normal lamp, and, on the other hand, being a variation which comes easily within the lines of the commercial manufactures.

Those two points determined, next came the unfortunate question of efficiency, as to the possible efficiency of incandescentl amps. Given a reasonably long life, there are as many opinions as there are makers of lamps, besides a very few stray opinions advanced by theorists, and still fewer advanced by practical men. A large amount of consultation was had on this topic. Some of the experts in lamp matters advocate the use systematically of lamps giving the candle power on not less than four volts. Others loudly proclaim that three or two and a half volts is quite a practical and reasonable figure. In this regard I shall have to appeal to the central station manager. Your Committee was necessarily at sea, to a certain extent, in determining this particular point; but after a large amount of consultation, both with central station men and with lamp manufacturers and experts, it would suggest that for the average central station to use, taking into account the fact that sometimes we are supplying lamps by contract and sometimes by meter, an efficiency of less than four watts per candle power is undesirable, particularly if the electricity is furnished by meter. When the consumer has to pay for more than four watts per candle power, he becomes inclined to kick and object seriously to the bills.

Then, as to the inferior limit of efficiency. On how small a number of volts is it possible to produce the candle power and at the same time have a lamp of reasonably long life and giving a reasonably uniform efficiency throughout its light? The very best commercial practice seems to set the figure a little over three watts. Without specifying, then, the efficiency for a normal standard lamp, your Committee would suggest that a lamp giving over 15, and not over 17, mean horizontal candle power, on a consumption of less than 60 and not less than 55 watts, represents the average conditions of central station practice perhaps better than any limit that could readily be found.

I am quite aware that in stating this 55 watts limit your Committee is running in the face of opinions which are entitled to some credit, but I would call the attention of any one who objects to that limit, to the fact that with this normal standard lamp, as thus defined, if a lamp can be produced giving the candle power with good life on a little over three watts it still falls within the standard. The effect in that case would simply be this: That the manufacturer who could produce a lamp giving the candle power well and steadily on a little over three watts, would furnish, as the standard lamp, a lamp which would come very near to the 17 candle power limit. In other words, he would get the credit for having a little brighter lamp than some of his contemporaries, and so would not, in any way, suffer by the establishment of that standard.

This suggestion for a normal standard incandescent lamp is the best that your Committee is able, as yet, to bring forward, and we trust that it will fall reasonably near the limits that most of the members of the Association have found in their actual practice.

Now, as to determining the mean horizontal candle power, on which our standard lamp should be based. Several difficulties were encountered in the beginning of this work. In the first place, the distribution of light that is given by an incandescent lamp is not altogether uniform. In lamps with twisted filaments the distribution is very uniform. In lamps of straight filaments, of round section, fairly uniform. In lamps of straight filaments, of square, or nearly square, section, it was something like that (indicating on diagram), showing the maximum at 45 degrees from the plane of filament. When filaments of rectangular section are employed, with a considerable difference of the length of the sides of the rectangular, the distribution may become almost anything, varying in the most erratic fashions, as you may see on this diagram.

Now, for all lamps giving a uniform distribution, a single reading on the photometer is enough to determine the candle power. In almost all of the twisted filament lamps, a single reading will determine the mean horizontal candle power closely enough for all practical purposes. When a lamp of this description is reached, a single reading might or might not be fair to the lamp. If the reading were taken at this point (indicating on diagram), it would be altogether too fair to the lamp, because a lamp which would give 16 candle power 45 degrees off the filament, would give nothing like 16 candle power mean horizontal intensity ; in other words, it would be measured at the maximum point. Contrariwise, measuring off the face of the filament would be very unfair to the lamp. In lamps of this general construction—and there are more than one make of them on the market—in reading off the edge of the filament, it will give in nearly every case a very close approximation to the average horizontal power. If one has a regular photometer at hand, three readings, at 120 degrees apart, taken anywhere on the lamps that they happen to have, will give an approximation, which in every case is correct within one per cent.

Now, taking a worse case of distribution (here Dr. Bell showed another diagram), you see the difficulties are even greater. Here the irregular circle is the actual distribution of the light, the outer circle is the mean horizontal intensity, and the inner circle is the alleged candle power of the lamp. I may state, in passing, that this particular make of lamp is now no longer manufactured, so that I won't be treading on the toes of anybody present. In that case no reasonable accommodation readings would give the mean horizontal intensity. For all practical lamps—in fact, for nearly all of them now used—one reading will give a very close approximation, taken anywhere in the case of the twisted filament lamp. Taken either with filament edge, on or about 30 degrees off that point, in the case of lamps having a squarish distribution, and in the lamps of more irregular character, it is only fair to say that one reading is not enough.

There is one way, however, of determining the mean horizontal candle power, and that is by spinning the lamp about an axis as it is being tested. If the lamp be rounded in a socket, and spun rapidly on its own axis, the mean horizontal candle power would be obtained at once, if the velocity of spinning rises above a certain point—above 300 or 400 turns a minute. This has been tried several times with more or less success. It is tried in, at least, one lamp factory with uniform and unvarying success, and it is certainly worth trying in case we have to deal with very irregular lamps.

Now (here Dr. Bell takes up another diagram), appreciating the fact that the average central station man has not an elaborate photometer and usually has no man whom he can train up to do accurate photometer work, your Committee suggest the use of a lamp tester; its purpose being to see whether the lamp falls within the standard limits as just defined. For that purpose a cheap and simple apparatus is all that is necessary. Take a board about 7 feet long. At about its middle point saw half way through the board and stick in the saw, cut a piece of tin painted black, about eight inches square, or of any convenient size, in fact, with a two inch circular hole cut through it. Over that hole put the photometer disc, merely a piece of thin paper, with an oil spot. Just 36 inches from that photometer disc place a lamp socket which can be twisted around its axis, fitting through the hole to carry the socket of the lamp which is to be tested. At the other end of the board cut a slot, and on a little slide set a lamp socket for a standard lamp. Make the slot of such a length that when the slide that carries the lamp is pushed up to its nearest point to the screen it shall be distant from it $34\frac{15}{16}$ inches. Make the other end of the slot far enough over so that when the lamp is pushed to that extreme end it shall be distant from the screen $37\frac{3}{16}$ inches. The latter situation will correspond to the 15 candle power lamp to be tested; the former position to the 17 candle power lamp to be tested. As regards standard lamps, if you are fortunate enough to be near a laboratory it is not a difficult matter to get a 16 candle power lamp of the voltage you use, giving preferred 16 candle power right off the plane of the filament. I wrote personally to Dr. Duncan, of Johns-Hopkins University, asking whether they could furnish standard lamps from their testing bureau. I regret to say that I have not yet heard from them, but doubtless their testing bureau will be able to furnish lamps which should give directly off the plane of the filament 16 candle power. These would serve as standard. With that apparatus fitted with measuring instruments, lamp testing can be carried on with great rapidity. The lamp to be tested and the standard lamp should both be on the same circuit in parallel; consequently, exposed to the same voltage. The rheostats in the series are prepared so that the voltage can be brought to the point intended. Measuring instruments of any kind that you have at hand will give the consumption in watts. Then placing the lamp to be tested in its socket and turning on the standard lamps, look at the photometer disc from this direction (indicating). If the lamp to be tested, then, is within the standard limits—that is to say, is under 17 candle power—when the standard lamp is pulled to the nearer end of the slot, the oil spot on the photometer disc will appear bright and lighter than the surrounding paper. Pushing the standard lamp to the further end of the slot it should appear dark, if the lamp being tested is within the normal standard. Thus, no setting is required. There are two positive things to be seen, one at each end of the slot. The photometer side should appear bright at one end and dark at the other, if the lamp is of the proper candle power. This avoids the difficulties of exact settings, and I think in most cases will eliminate the personal error that is sometimes very vexatious.

It was felt by your Committee that some such device was necessary in order to prevent the careless photometer work on the part of the linemen and the station man to whom the thing might be intrusted. It is very rarely that the manager of a station himself has the time or cares to go to the trouble of going through this testing himself, and it is not always practical to secure a thoroughly competent man to do it. So the intention of the Committee was to devise a lamp tester which should define the maximum and minimum range allowed without requiring an exact setting.

Therefore, Mr. President, I will leave the report for any member of the Association to ask any question about it that may be desired. (Applause.)

THE PRESIDENT: Are there any remarks on this subject? As there does not seem to be any, the next business will be a report from the Committee on Legislation, and Judge Armstrong will make the report.

REPORT OF THE COMMITTEE ON LEGISLATION.

JUDGE ARMSTRONG: Mr. President and gentlemen: In making the report of this Committee, I will state that it was the idea at the outset to have a representative on the Committee from each State in the Union, to receive at the headquarters of the Convention, the Secretary's office, a report of all matters of legislation pending in the various State Legislatures. Very few, if any, of the reports have been received. So that, I presume, it is safe to apprehend that very little legislation outside of the ordinary course has been, or is being, attempted, The most of the State Legislatures being now in session, of course, the report cannot be and is not as we should be able to have it at a Summer Convention. In our own State, New Jersey, the regular line of bills to bury all wires underground, to put them 100 feet above ground, and to carry them along in various ways, are in—they are always there. (Laughter.) They have a peculiar name, not entirely complimentary or polite to the legislatures to call it, and so in my report I will say nothing about what we usually know them as. (Laughter.)

In making this report, I presume, we all, as representatives of companies, must remember that we have more than a commercial duty to perform. No electric light company supplying light can claim to be entirely or solely an independent business corporation. Every one of us has assumed for his company certain public duties and responsibilities. When my company engages to light a city, it has engaged in a very serious responsibility. We, therefore, are more or less reasonably subject to legislation and legislative enactments, from municipalities, as well as from States and State Legislatures. Being so, there is grave danger, however, that some license, some power, properly given, may be carried to dangerous and injurious accessions from mistaken zeal or other reasons.

I have a report here from Mr. George C. Maynard, from the District of Columbia, in which he says:

REPORT OF THE NATIONAL COMMITTEE ON LEGISLATION.

SECTION FOR THE DISTRICT OF COLUMBIA, BY GEORGE C. MAYNARD, MEMBER OF COMMITTEE.

It has been my special duty to look after Senate Bill, No. 4,329, introduced by Senator Hale on the 15th of August, 1890, and referred to the Committee on Census.

A copy of memorials adopted at the Twelfth Convention, was mailed to all members of the Association and to Boards of Trade and commercial bodies, from the office of the Secretary, in New York. In addition to these, 500 copies were mailed from Washington to various other persons and corporations.

Resolutions strongly urging the passage of the Bill, adopted by the following named organizations, have been presented to the Senate and referred to the Census Committee:

National Board of Trade and Transportation, New York City.
Indianapolis Board of Trade, Indianapolis, Ind.
Master Builders' Exchange, Philadelphia, Pa.

Chamber of Commerce, New Haven, Conn.
Merchants' Exchange, St. Louis, Mo.
Retail Grocers' Association, Lincoln, Neb.
Commercial Club, Kansas City, Mo.
Association of Edison Illuminating Companies.
Norwich Board of Trade, Omaha, Neb.
Wilkes Barre Board of Trade, Wilkes Barre, Pa.

In response to the memorials sent from Washington, I received from a considerable number of prominent companies and individuals communications stating that special personal appeals had been made to senators and representatives, asking their support of the Bill.

Accompanying these replies were copies of letters from many senators promising their cordial support of the measure whenever it should come up.

These communications were from :

The Standard Underground Cable Co., Pittsburgh, Pa.
The Utica Electric Co., Utica, N. Y.
Citizens' Illuminating Co., Brooklyn, N. Y.
Wheeling Electrical Co., Wheeling, W. Va.
The Simplex Electrical Co., Boston, Mass.
J. J. Burleigh, Camden, N. J.
William B. Wilson, Philadelphia, Pa.
F. B. Knight, Austin, Texas.
George N. Stone, Cincinnati, Ohio.
M. B. Leonard, Richmond, Va.
H. B. Chamberlain, Denver, Colo.
George M. Dugan, Jackson, Tenn.
Noah H. Cheever, Ann Arbor, Mich.

In addition to this work, which is of record, a great deal has been done by members of the Association and others, by private letters too, or personal interviews with senators or representatives.

So far as I learned, not a single congressman has made any objection to it, and nothing but the extraordinary pressure of important business has prevented its passage. It may reasonably be expected that the Bill will pass at this or the next Congress.

The Illinois Electric Lighting Association has sent out to its various companies a circular referring to matters of legislation in the State Legislature of that State, which is now engaging their attention, as follows:

ILLINOIS ELECTRIC LIGHTING ASSOCIATION,

53 DEARBORN STREET, CHICAGO, Jan. 17th, 1891.

GENTLEMEN:—An effort will be made at the present session of the State Legislature to pass a Bill authorizing cities and towns in Illinois to operate electric lighting and power plants for the purpose of commercial, as well as municipal lighting.

The injury to our mutual interests which would result from any such legislation is too apparent to call for special comment. One and all of us who have investments in electrical central stations are deeply concerned in the defeat of any measure which so palpably aims at our very existence. The urgency of the situation demands immediate and united action on the part of all concerned in electrical distribution. The passage of such a Bill means the practical destruction of our capital, and if any efforts on our part can avail to thwart this movement, now is the time to put them forth for the sake of preservation.

If each one of us will use the influence he may be possessed of with the local representative to the Legislature, and if each company will lay the facts before the Board of Directors and induce them to bring the weight of their arguments to bear upon our legislators, it is possible that the designs of the demagogues may be frustrated.

The Illinois Electric Lighting Association was organized with a view to just such an emergency as this. The responses to the calls which were sent out at its inception were very few in number, probably because at that time the central stations throughout the State did not appreciate how soon they might be called upon to act in concert. Small as the Association is, however, it proposes to do all that it can, but it is evident that its work would be much more effective if it were more respresentative of all the central stations in the State, and it is suggested for your consideration that you take the matter of joining the Association once more under advisement. In the meanwhile, it is imperative that the personal efforts of everybody interested be exerted toward the defeat of the proposed action of the Legislature.

The acknowledgment of this letter and a statement of just what you can and will do to this end will be appreciated, and will probably greatly aid in accomplishing the work we have before us.

Yours truly,

C. H. WILMERDING, *President.*

May I urge upon the representative of the companies here, particularly those who may be upon this Committee, that they will take pains to send any information concerning the matters of legislation. In the report of our proceedings the Secretary has compiled here all matters that he may get hold of relating to legislation before our various State Legislatures, and what was done with various projects. There were some mighty novel projects introduced, and this will show what has been done. There are some interesting matters which have been and are being considered by the New York State Legislature, and also by the Legislature at the present time in the State of Massachusetts. There will be found some very interesting reading in this book for those who are concerned, as we all are, in these matters, and who may all be concerned, in these various items of legislation.

I suppose that Massachusetts has had the most uncomfortable experience lately of any of the States. Mr. Everett W. Burdett, who is the attorney of the Massachusetts Electric Association, of Boston, is here to-day, and he will make a report upon matters in the Massachusetts Legislature. Mr. Francisco, from Rutland, will, I believe, make a report of what has been done in Vermont. Now, if we can get to the Secretary all of the Bills and measures that are pending before the various State Legislatures, and a statement of what has been done concerning each of these things, it will make in time a very valuable library upon this one point.

We are very young, but it seemed marvelous to me, as I sat here this morning and heard what I did here, that we had lived only six years; the ideas are now so settled. I have thought that possibly electricity, having annihilated both time and space, ought to have no past and ought to have no future, but be a continuous present. We do not count time by electricity. We have annihilated space; we have annihilated time in communication, and now, from various points of illumination (we have heard of them to-day from Lynn and other places), we propose to annihilate night, and then there will be a continuous To-day. So I suppose we are altogether in the Present.

Therefore, we want to get all these things here so that we may know what the present is doing, and protect ourselves—not from intentionally wrong legislation, but ignorantly wrong legislation. I will now call upon Mr. Burdett to report about matters in the Massachusetts Legislature.

MR. E. W. BURDETT, of Boston: Mr. President and gentlemen: I may premise the short report which I shall read with a statement, which, I dare say, will be disputed by nobody, and that is, that in Massachusetts we have now and have had in the past more attempted legislation to the square inch than in any other community, large or small, within the boundaries of the United States. Our experience has been not, as yet, painful, because nothing has been accomplished of any account upon the other side, but it has certainly been interesting, and, I think, it will be instructive to those representing this interest in other States. Referring, for a moment, to what has been said by the Chairman of your Committee—and I appear here in the place of Mr. Gilbert, who is a member from Massachusetts, and at his request—I may say, that last year and this we have had printed a copy of every order or suggested law which is pending, or has been pending, before our Legislature, and that has been sent out to about 500 persons in the State directly interested in the industry, and, in that way, we have spread throughout the length and breadth of Massachusetts accurate information as to what was on foot, and followed it up, as I did yesterday, for the year 1891, with brief statements of reasons which should be given adverse to the proposed legislation. I think the list of subjects which were before the Legislature of 1890 are printed in the volume of the Association's last Convention Proceedings, although I have not had an opportunity to examine it, and the same matter has been printed for the year 1891 within a day or two, and is to be distributed forthwith.

The matters affecting electric lighting interests which were before the Massachusetts Legislature of 1890 are reported in the Proceedings of the last Convention of this Association. They consisted of 16 orders and numerous petitions, upon all of which action was had by Committees of the Legislature. The only law which resulted from this agitation, was Chapter 404 of the Acts of 1890, relating to the regulation and supervision of wires over streets or buildings in cities. This Act requires the suitable insulation of all wires at points of attachment, strong and suitable supports, the removal of all abandoned wires, appliances calculated to prevent currents of electricity capable of injuring electrical instruments, or causing fire, from entering buildings, and the tagging or marking of each wire or cable so as to designate the owner or user thereof. It further provides for the appointment of an officer to supervise all wires in cities, to remove abandoned wires, and generally to have the supervision of the use of wires.

There is pending before the present Legislature a proposition to extend this act to the towns as well as the cities of the commonwealth, and to enlarge its provisions in its application to the city of Boston.

The agitation in favor of the enactment of a law to permit a municipality to own and operate gas and electric light plants resulted in a Bill, which was passed to be engrossed by the House, but it was referred by the Senate to the Legislature of 1891. This Bill is now pending before the present joint Committee on Manufactures. While this Bill was pending in 1890, the House of Representatives required the opinion of the Justices of the Supreme Judicial Court upon the questions whether it was within the constitutional power of the Legislature to enact a law conferring upon cities and towns the power to manufacture electric light for use in the public streets and buildings of such cities and towns, and for the purpose of selling the same to their citizens. Both questions were answered in the affirmative. The decision mainly turned upon the question whether the manufacture and distribution of gas and electricity by cities and towns for illuminating purposes is a public service within the meaning of the Constitution (Part II, Chap. 1, Sec. 4). The Court held that the maintenance of public streets and buildings is a public service; that they may be lighted at the public expense. That the means of lighting is a matter of expedience; and that the Legislature may authorize this to be done by any appropriate means which it may think expedient. As a question of constitutional power, the right to authorize cities and towns to buy gas and electricity for their use, cannot in the opinion of the Court be distinguished from the right to authorize them to manufacture it for their use. The first question was, therefore, answered in the affirmative. The second question was one of more difficulty, owing to the difficulty of defining with entire accuracy all the characteristics which distinguish a public service and a public use from service and uses which are private. But the same conclusion was reached.

The Court did not consider whether the furnishing of gas and electricity for supplying heat and power can be regarded as a public service, and expressly they did not pass upon that question.

This opinion of the justices having been received, the Bill was taken up by the House and passed, though in a somewhat different form from that submitted to the Court. It permits any of the cities or towns of Massachusetts, not only to establish plants by purchase or otherwise, for municipal purposes, but to supply light, heat and power by means of gas or electricity to any of their inhabitants. It also permits any city or town thus establishing a plant to supply gas or electricity, for any or all of the purposes named, to adjoining cities and towns and to the inhabitants thereof. It contains no provision requiring the purchase by cities or towns establishing municipal plants of plants already existing in such places, and permits the purchase of only that portion of existing plants that consists of "real estate or is attached to real estate so that it cannot be removed and rendered available elsewhere without material loss, injury or expense."

In case of companies supplying both gas and electricity, the Bill permits the purchase of one or the other branch of the business, as the town or cities may elect.

Notwithstanding the failure of this Bill to become a law, the town of Peabody voted to establish a town plant for lighting its public streets, and incidentally to utilize its surplus power and apparatus in supplying private consumers. A Bill in equity was brought to restrain the town from carrying this vote into effect. The case has been decided by the full bench of the Supreme Judicial Court, and will be recorded under the name of Spaulding *vs.* Peabody, in Vol. 151, Mass. Reports.

In deciding this case, the Court said, that the authority claimed for the town is not within any of the customary powers which towns from very early times have exercised, and must be derived, if it exists, from the statutes relating to towns. The authority was claimed under the provisions of a statute which employs language first used in an act of 1692—that a town may grant "money for all other necessary charges, arising in such town, and from the authority of towns to erect and maintain street lamps." But the Court pointed out that the phrase "all other necessary charges" has been given a very limited scope, and that special enabling provisions have been deemed necessary whenever extensions of the courtesies of town expenditures have been sought. As to the claim that the power was incident to that of erecting and maintaining street lamps, the Court said: "The subject of construction and maintaining gas or electric works for the manufacture of gas or electricity, and the distribution of them through the streets of towns or cities, for the purpose of furnishing light, is one of too much importance to be attached as a mere incident to the power given to erect and maintain street lamps, and we think that if the Legislature had intended that towns generally should have authority to erect and maintain such works, the authority would have been plainly expressed in statutes, with such limitation, and accompanied by such restrictions as the Legislature might think it prudent to establish. We see no indication in the existing statutes that the Legislature intended to make provision for the exercise of such authority by the towns of the commonwealth."

In order to leave no doubt upon the question whether towns and cities can, under existing laws, establish and maintain plants for municipal purposes, only some of the opinions concluded as follows: "If we assume that the only action now contemplated by the Town of Peabody is the erection and maintenance of electrical works for the purpose of lighting its streets, still we are of opinion that the vote is beyond the legal rights and power of the town." P. S. Chap. 28, Sec. 129.

This decision upon the existing state of the law in Massachusetts, as well as the opinion of the justices upon the constitutional questions involved, is herein stated with some particularity, owing alike to the importance of the questions and the eminent authority of the court which has passed upon them. While both opinions rest largely upon the particular language employed, in the one case in our constitution, and in the other case, in our laws governing towns, they involve the consideration of such important general principles that they are worthy of study in any jurisdiction.

In connection with the Bill for municipal ownership, the Committee on Manufacture has before it the recommendation of the Governor that the powers of municipal corporations be enlarged by general law in the matter of municipal control of municipal work and ownership of the instrumentalities for its performance, which, it will be observed, does not go to the extent of recommending the enlargement of the powers of towns and cities so as to enable them to manufacture and supply gas or electricity for commercial purposes. The Governor is on record against an extension of the law in the latter direction. In addition to the Bill above referred to and the recommendation of the Governor, there are orders covering the same subject matter and numerous petitions in aid thereof; including a petition of the Common Council of the City of Boston. The extent to which some of the petitions go is shown by the fact that in one case the passage of a law is prayed for to enable cities and towns to engage in all lawful business that the citizens of such cities and towns may desire to enter into. Another prays for a State loan of $3,000,000 to cities and towns, to enable them to build for the people, similar to State loans to railroad corporations. Separate petitions have been filed by the towns of Danvers, Peabody and Hudson, and the towns of Brookline and Melrose have voted to appear in favor of the general legislation.

The hearings upon this subject are now in progress. Before the same Committee there are pending Bills to provide for State inspection of electric lights and meters, for the abolition of the Board of Gas and Electric Light Commissioners and the appointment of a Board of Gas and Electric Light Control in its stead; and for the consolidation of gas and electric light companies situated in the same city or town, with a capitalization equal to their appraised valuations. Before the Committee on Mercantile Affairs the following orders are pending:

For the extension of the provisions of Chapter 404 of the Acts of 1890 to the towns of the commonwealth, and the enlargement of the same in their application to the City of Boston (already mentioned); for the better regulation and control by State, city and town officers of the acts and business of persons, associations or corporations making use, for business purposes, of wires over or under the public highways, and regulating by law the incorporation of companies for such purposes, and all proceedings and work to extend such wires over or under the public highways; for legislation for the better protection of persons and property against injury from electric wires; for further legislation as to granting locations for poles to companies in towns, and as to authorizing the selectmen of towns and the aldermen of cities to re-locate and remove, at their discretion, the poles of electrical companies from the streets and highways; notwithstanding any prior grants or permits to erect and maintain the same, and also to compel the joint use of poles by different corporations.

Before the Committees on Cities and Taxation are pending several orders as to authorizing cities and towns to prescribe terms and conditions and to impose taxes for the use of their streets by private corporations; as to the expediency of abolishing the State corporation tax on corporations exercising municipal privileges, and so taxing such corporations that the towns and cities in which such municipal privileges are exercised shall receive the entire tax; and other orders of a similar nature. There is also an important order pending before the Committee on Cities as to the expediency of authorizing the City of Boston to make contracts for 20 years or less for lighting its streets, public places and parks, and to grant exclusive rights for the use of its streets as a consideration for such contracts.

The foregoing statement includes, in outlines, all matters of legislation and adjudication, with one exception, touching electric lighting interests which have arisen in Massachusetts since the last report.

The exception referred to is the decision of the Supreme Court in the case of Suburban Light and Power Company *vs.* The Aldermen of the City of Boston, reported in Vol. 150, Mass. Reports. In this case it is decided that the granting of pole locations to electric light companies is not mandatory under our statutes (P. S. Chap. 109, Sections 2 and 3) upon Aldermen or Selectmen, but rests entirely within the discretion of those officials.

MR. FRANCISCO: Speaking for the State of Vermont, I would say that we have not had very much trouble. The only case we have had in my own town, Rutland, was about a year ago, in regard to municipal ownership. The Aldermen conceived the idea that they could furnish electric lights without any expense to the citizens. They became convinced that that could be carried out through the influence of outside parties, and the wonderful stories told by different people; but by concerted action we had the matter referred to the popular vote, letting the masses vote upon the subject, as they did in the regular election, and the result was that the vote cast was 10 to 1 in opposition to municipal ownership, which eventually ended all strife on that question in that town for all time to come, I think. In the Legislature we had a Bill introduced, allowing one company to occupy the poles of another company, and that Bill was killed in the Committee Room. We also had a Bill introduced, which became a law, compelling all companies to remove all crooked poles, or poles that were not first-class in every respect, and replace them with new, straight and perfect poles, and paint all poles within the city limit. We had a Bill introduced at the last session requiring all electric light companies in running their lines to run the lines entirely distinct from, and in such a manner as not to interfere with, the business or the wires or occupation of the telephone companies. That Bill died a natural death in the Committee Room. There was also a Bill introduced at the same time requiring telephone companies to comply with the same law and not run anything but metallic circuits with proper insulation. When that came up the telephone companies were anxious to have it die, and that died, also, in the Committee Room.

That is the only legislation that we have had in our State since our last meeting.

MR. GEORGE R. STETZEL, of New Bedford: I should like to inquire if there has ever been a case where an electric light company had asserted any right to any property in the street in the use and transaction of their business? I represent a company in the State of Massachusetts, and, as I understand it and as we act, we are very much in the position of the popular interpretation of the Dred Scott decision; we have no rights that the white man is bound to respect; the city does as it sees fit in every instance, and we don't know of any method of redress. Out of perhaps 800 poles there are from 80 to 100 that are used for any purpose that the municipality may see fit to put them to. Within the past three months the city has been establishing a police signal system; but they have put their boxes on our poles, sawing some of the poles two inches needlessly, and, it looks to me, maliciously, that they may have a base for the box to rest on the pole. They have not only done that, but they have taken the wires from the top of the pole down through the boxes through an iron gas pipe and from that box they go directly into the ground. My linemen say it will be a difficult thing to sit on top of that pole in damp weather when, if any trouble should arise I might order them to go to the top of the pole and rectify it. While I have filed a protest with the City Government and a notice that I shall hold them responsible for any damage to my workmen or to citizens, there has been no action taken as regards remedying their gross imposition on our rights, if we have any. It seems to me that we should not only act a little on the defensive, but that in this matter if we have any rights we should assert them. I do not know that we have any rights, but it certainly is very disagreeable to a manager to have the best property which he has confiscated in this way without any knowledge of or consent to it on his part. The first I knew of the establishment of this police signal business by the city was that they were established and they were there. They did not have any consultation with me or with any officer of my company. Now, I consider this a menace to the life and limb of my workmen, and something that money should not and could not have bought from us. I never should have consented to any condition that would multiply the opportunities for accidents, because such accidents are so serious in their consequences to our industry. As regards the conditions in Massachusetts, it seems to me that we are simply the objects to be fought, without regard to our rights. Before the Committee, which has a meeting to-morrow, and which I shall leave here to attend, the broad ground is taken that we have no rights, and that is the nature of the legislation which will be established in Massachusetts without doubt. As regards taxation, as I say, we furnish from eight to ten per cent. of all the poles that the city uses; and, as regards the matter of the obstruction of the streets, so far as that goes, they must have those poles, so that our interests demand that we obstruct the streets, but we furnish the poles and pay the bills, which represent a large money value; and now this legislation is that we shall be taxed on every pole set in the street for the benefit of a municipality. I think it is about time for us to try to work up some aggressive warfare and not be entirely on the defensive.

MR. BURLEIGH: May I interrupt the gentlemen for just one moment? Professor Thomson's paper was so able and interesting and so very instructive that I want to move a vote of thanks to Professor Thomson for his trouble and pains, and to express our pleasure.

The motion was seconded from various parts of the house and unanimously carried.

MR. BURDETT: I would like to ask the gentleman who has just spoken from what city in Massachusetts he comes?

MR. STETZEL: From New Bedford.

MR. BURDETT: And I wish to correct some of the ideas which he erroneously holds. If he has been advised that he has no rights to the exclusive use of his poles he has been incorrectly advised. There is a very great doubt as to the right of the city to interfere with a pole which has once been set, except to change its location. Now, as to the aggressive attitude which he speaks about, I would say that the difficulty with the gentleman is that he has not attended to these things at the State House in Boston. I never saw his face until this afternoon.

MR. STETZEL: I am new in the business, sir.

MR. BURDETT: Your company, according to my recollection, is not a member of our organization who are fighting these things. If it had been you would have been kept informed of what was going on. However, sir, I shall be very glad to see you in Boston at our meeting to-morrow when we shall attempt to inaugurate something in the way of aggressive action. As a matter of fact, the Electric Light Association, which I have had the honor to represent, have been fighting for their lives, and not fighting for the other fellows, and that has got to go on until we have strangled this insane agitation and then we can turn upon them with something in the nature of an aggressive warfare. The proposition before the Committee to-morrow is to take away the rights which

I say now exist. It has arisen out of the petition of the Mayor of Salem, to be permitted to have all Boards of Aldermen and Selectmen given authority to revoke absolutely every pole location in a city or town without any reference to prior grants which have been acquired. There is only one way of fighting it, and that is for all the companies to come together. The telephone companies and the street railway conpanies have joined us, and we have all combined, and we propose to sit upon the rights which we now have. I say this to the gentleman, that he has rights with his poles in the street, and he should join us and help to maintain them ; and I shall be glad to see him in Boston. A gentleman sits here at my right who represents a company from the eastern part of the State, who can testify that his particular company was saved from competition with a company which would have run him out of the town, in spite of all he could do, because they proposed to use a water power which up to that time had not been used. (Applause.)

MR. DE CAMP: I would say that in the State of Pennsylvania the municipal authorities recognize the rights of the companies to their poles when they have once become established. I don't know that a company has ever been interfered with. The city of Philadelphia makes a respectable application to us for the right to use our poles, as we do to them for the right to use theirs. Some five years ago, when the question of the removal of poles was up before the Legislature, the very eminent counsel who argued the case took the position that it did not seem to be questioned that in case such a law was passed, which would mean the destruction of a vast amount of property for the use of which it was erected, the companies would be entitled to compensation. That, of course, has never come to an issue, but there seemed to be no two opinions about it.

The President: If there is no further discussion, a motion to adjourn would be in order.

On motion, the Convention then adjourned until Thursday, February 19th, at 10 A. M.

ORDER OF BUSINESS.

THURSDAY, February 19th, 1891.

FIFTH SESSION, 10 A. M.

1. Paper, "The Ferranti System."
   By C. D. HASKINS.
2. Paper, "Distribution and Care of Alternating Currents."
   BY T. CARPENTER SMITH.
3. Paper, "Mutual Insurance of Accounts."
   By FREDERICK A. C. PERRINE.
4. Report. Committee on Data.
   A. J. DE CAMP, Chairman.
5. Report. Committee on World's Columbian Fair.
   MARSDEN J. PERRY, Chairman.

SIXTH SESSION, 3 P. M.

EXECUTIVE SESSION, TO BE ATTENDED BY ACTIVE MEMBERS ONLY.

6. Paper, "How can the National Electric Light Association best serve Central Station Companies."
   BY C. R. HUNTLEY.
7. Report. Secretary.
8. Report. Treasurer.
9. Election of Officers.
10. Selection of place for next Convention.

FIFTH SESSION.

THURSDAY, February 19th, 1891.

The Convention was called to order at 10:20 A. M.

THE PRESIDENT: The first thing on the calendar this morning is a paper on the Ferranti System, by Mr. C. D. Haskins.

MR. HASKINS: I want to say, in the first place, that my paper is a sort of adjunct to some photographs that I have of some Ferranti machinery. If I had not had the photographs I do not think I should have been willing to undertake the paper, because the photographs are what are going to be interesting.

Mr. Haskins then read the following paper:

THE FERRANTI SYSTEM.

GENTLEMEN: I keenly appreciate the compliment which your Committee has paid me, in naming me to appear before you to-day to read a paper.

I fully realize that much is expected of me, and I believe I even more fully realize my inability to handle the subject with the completeness which I could wish.

My connection with Mr. Ferranti was not of long duration, and it is now some time since I severed my connection with him, so that my information, whilst pretty complete as far as it goes, is not as thoroughly up to date as it should be.

The Deptford station was far from finished when I left London, and 10,000 volts generated direct from the dynamo was still a matter for surmise and conjecture.

Under these circumstances the best thing I can do, I believe, will be to take up each feature of the system separately, and describe it to you in its various forms and applications as thoroughly as I can. Starting with this plan in view, I have arranged my paper under the following heads:

Methods of Distribution.
Ferranti Dynamos.
Ferranti Transformers, Fuses, etc.
The Ferranti Meter.

Starting, then, with Mr. Ferranti's methods of distribution, I will deal first with the old and somewhat famous Grosvenor Gallery station, from which current, at a pressure of 2,500 volts, was distributed throughout the most wealthy portion of London's West End, by means of overhead wires.

At the Grosvenor station there were two dynamos, each of 625 horse power nominal. These machines I will describe later on.

From these generators the circuit was carried to five double-pole, double-throw switches, each having a break of two feet and breaking both sides of the line at once.

Each of these switches represented a circuit, there being five circuits in all from the Grosvenor station. It will readily be seen, therefore, that the switchboard of this station, which distributed light to no less than 35,000 lamps, was an exceedingly simple affair, yet, with their five switches, any desired combination of machines and circuits could be made.

It has quite frequently been stated, I believe, that these two machines at the Grosvenor were run in multiple. This is in no sense true, though, since the removal of these dynamos to Deptford station, they are to be connected in this manner, I understand.

From the five main switches the current was carried through Ferranti plug fuses of rather peculiar construction, having a break of two feet. These fuses I shall describe later. From the fuses the circuits were carried on ordinary wiring to an overhead distributing pole. From this center the wires branched in five directions, being carried over the house-tops, and not through the streets as is our custom in America.

Stranded steel cables $\frac{7}{16}$ B. W. G. are stretched from pole to pole, and from these cables the mains are supported at frequent intervals by means of leather thongs or slings, thus saving undue chafing and straining of the conductors. This method of supporting the mains presents many marked advantages; the wear of insulation is reduced to a minimum, and the liability to a ground is very much diminished. The leather slings stand the wear and weather exceedingly well, and renewals are much less frequent than would be expected, especially if one takes one's foot-wear as a basis for calculation.

All streets are crossed at right angles, and no difficulty is experienced with the ubiquitous telephone man.

Contrary to the custom in this country, the primary wires are generally run into the house to be lighted, where they are connected to the transformer, a Ferranti fuse being placed in the circuit.

The secondary conduits are of 50 or 100 volts pressure, as may be required, and the house wiring is quite of the usual style, having a principal secondary fuse at the transformer, and a Ferranti recording meter in series with the lamps.

The Grosvenor Gallery as a generating station is now a thing of the past. It has been reconstructed, and is now one of the four transforming centers of the Deptford system, which draw their energy at the phenomenal pressure of 10,000 volts from the machines in the great station on the Thames.

This heavy pressure is reduced at these central points by means of large transformers, and is distributed over the London house-tops at an electromotive force of 2,500 volts in the manner I have already described, the only difference here being that these overhead mains are on a secondary instead of a primary circuit, and the house circuits become tertiary instead of secondary.

The portion of the Ferranti system of distribution which has given rise to the most interest, and which has been talked of, is the present primary circuit, extending from Deptford to the four central distributing stations in London.

Many curious and wonderful letters regarding this have appeared in our journals at various times, and have given rise to much confusion and many wild conjectures, whilst the real facts of the matter are, I believe, but little understood.

The shape and principle of Mr. Ferranti's concentric main is familiar to all, but a few words descriptive of it may not be out of place here.

Over a copper tube, about one and a half inches in diameter, insulation is wound in the form of a stout manilla paper, thoroughly saturated with a special insulating compound. This insulation is wound on to a thickness of one-half inch by a machine specially designed for the purpose by Mr. Ferranti; over this insulation a second copper tube is placed, of the same sectional area as the inner one, and this is drawn down till tight.

The cable is made in lengths of 20 feet, and stands static tests of immense pressure. Special plug and expansion joints are provided for connecting the lengths, which are also thoroughly reliable.

The original intention was to lay these mains with the outer tube directly to earth throughout its entire length, thus rendering the system absolutely safe, since only one side of the circuit could be touched by the hand, and there would be no difference of potential between this and the ground.

Alternating circuits and grounded telephone lines do not agree, however, and the law demanded that the Ferranti mains be laid duly insulated from earth ; this is therefore done, but one terminal of the machine is still connected to ground, and comparative safety is the result, since it will readily be seen that, to short circuit through the body, it would still be necessary to touch the inner tube of the conductor. This would necessitate cutting through the outer tube and insulation, which would mean a short circuit from tube to tube, through the cutting instrument, a dead-short circuit on the machine certainly, but perfectly safe for the meddler.

At the collector boxes of the machines an accident is impossible, since the collectors are enclosed within an iron box, the lid of which is magnetically locked by the exciting current—nor can the machine generate when the box is open, since the exciting circuit is not complete till the box is closed.

Unfortunately, time was an object in the starting of the Deptford station, and much contract-made cable was laid ; the greater part of this was the lead-covered cable so frequently mentioned ; this was not of the concentric pattern, but an ordinary stranded cable—I understand that it was guaranteed to stand considerably above 10,000 volts, but after being laid it was found not to stand 10,000 at all, and to give but poor satisfaction even at 5,000.

This unfortunate trouble has given rise to much talk, and has been scarcely well understood by the general public.

Several other kinds of cable were tried, but gave equally unsatisfactory results, and all mains have doubtless by this time been replaced by the Ferranti concentric cable, which stands the pressure perfectly and gives most satisfactory results.

Of the various expedients to which Mr. Ferranti had recourse during this trouble with the cables, I am not prepared to speak, first, because I am not fully informed regarding them, and, secondly, because they formed no portion of the Ferranti system of distribution. They were simply makeshifts, necessitated by an unfortunate happening and by lack of time, and they have probably given rise to more discussion, both in and out of the papers, than has the system itself.

I will now pass on to a description of some typical Ferranti dynamos. First among these, a few words are due to the original form of Ferranti alternator, which, while it is no longer manufactured, still, without a doubt, was a machine of marked efficiency and great originality.

The characteristics of this earliest dynamo were, I think, about as follows: The figures are not based upon my personal experience, for the machine was out of date long before my time, but upon various fragmentary notes from my pocketbook, and a generous quotation from Thomson's "Dynamo-Electric Machinery."

As in the Siemens machine of similar type, the fields formed, as they do now, "two upright circular crowns of electro-magnets with opposing poles." There were 16 magnets on each side, 32 in all.

The peculiarity of the machine lay in the armature, which consisted of a series of zig-zag loops, eight in number, wound or folded one layer upon another, and separated by alternate ribbons of strip insulation of similar width. The winding was in three multiple circuits, each strip making 10 turns around the zig-zag coil, 30 layers of winding in all.

Each of these three coils are connected at one end with a solar star-shaped brass boss, which, bolted together from either side through the loops of the zig-zag coil, and at the same time connected directly with one of the collector rings, the three coils all again uniting in an inner star-shaped piece of brass, which in its turn communicated with the second collector.

The disc armature was 30 inches in diameter and one-half inch thick. Its extreme thickness permitted the magnet poles to be brought very close together, enough space only being allowed to insure safe clearance. The natural result of this was a very efficient field.

The dynamo was calculated for a speed of 1,400 revolutions per minute, and maintained a pressure of 100 volts. The armature weighed less than 100 pounds, and the entire machine rather less than one and a half tons.

Most of these old machines are still in use, principally upon British war-ships, and are doing good service.

An excellent type of all the more modern Ferranti machines is the 150 horse power dynamo, which has been manufactured in considerable numbers, and is the alternator generally in use in most of the smaller stations using the Ferranti system.

In this machine the number of parts has been reduced to a minimum, and the efficiency is very high; it will fully illuminate 3,000 ten candle power lamps, requiring an average energy of over 35 watts each.

The fields are arranged as in the old machines, and have 20 magnets on each side. The distance between the opposing faces of the fields is rather less than three-quarters of an inch, and within this narrow space the coils of the armature rotate at a speed of 400 revolutions per minute. The armature being four feet in diameter, this makes a peripheral speed of 4,800 feet per minute. The diameter of the armature shaft is four and a half inches, which at first sight seems rather large, since there is no great weight to carry, but the size is needed since the armature is overhung.

This armature is without iron, and consists of a central boss of gun metal, into which are fixed ten carrying-arms of brass. These are insulated and held into the core by a special mixture of sulphur, which is poured in a liquid state and sets harder than the metal itself.

This sulphur insulator is one of Ferranti's specialties and prides, and much of the success of his machine is, I believe, due to it. I never, during my stay with him, met with a ground on an armature shaft.

Each of the ten carrying-arms, which I have just mentioned, hold two coils or bobbins of copper tape, tightly wound by machinery on a center made up of alternate strips of asbestos and brass. Terminating at one extremity is a gun-metal butt-piece, the entire coil being fastened to the carrying-arm by a single bolt passing through this butt-piece and drawing the bobbin into place.

The winding of the bobbins themselves is of alternate layers of corrugated copper and fibre ribbon, the object of the corrugation being to prevent lateral slipping—a very necessary precaution.

The thickness of the bobbins, which form the only portion of the armature projecting between the fields, is one-half inch, which leaves a margin of less than one-eighth inch clearance on each side.

The coils are connected in two parallel circuits, which are conducted away through the carrying-arms and rods within the central boss itself to the collector rings, where the current is taken off by Ferranti collectors—two half circular pieces of metal like the two halves of a severed ring, which almost surround the collector rings and are held together by bronze springs, making an extremely good and constant contact, and not running at all hot.

The machine can be very quickly repaired; the two fields are divided at the center and slide back very readily, right and left, on extension bases, by the aid of a simple levering device. The armature is then exposed, hanging in its usual position, and it is but the work of a moment to take out and replace a burnt coil with a new one.

A few details regarding the two 625 horse power machines formerly used at the Grosvenor station, and now being installed with changed winding to take the light day load at Deptford, may be of interest here, before I pass on to a description of the giant machines of the Deptford station. These two dynamos are in construction almost exactly like the 150 horse power type which I have already described. The machines were originally designed to give current for 10,000 ten candle power lamps each, but have frequently carried as high as 19,000 lamps without apparent effort. The weight of these dynamos is 35 tons. The height from floor is 9 feet 6 inches; the floor space required, 9 by 11 feet; armature diameter, 8 feet 6 inches; potential maintained, 2,500 volts; speed, 280 revolutions per minute.

There are 40 coils or bobbins in the armature and 40 field magnets on each side, 80 in all. The pulley is grooved for rope driving, Mr. Ferranti being fully convinced that this is infinitely better than the best belting.

It has probably been already remarked that I have made mention of no regulating device for the dynamos. Mr. Ferranti makes no provision for automatic governing, nor is it needed. It must be remembered that there is absolutely no iron in the armature, and that the machine is, therefore, self-regulating to a very large degree.

There is no compounding of the field, the field circuit being entirely simple and separate. At the Grosvenor the exciters used were Siemens machines, giving 108 amperes at 100 volts. At Deptford, Kapp machines coupled direct to Allen engines are used. The Kapp machines have rheostats in their field circuits, not for use in regulation, but for starting up and in case of emergency. It will be noticed that the two machines I have just described have not armatures arranged with the zig-zag winding adopted in the original Ferranti machine. This zig-zag winding was abandoned for several reasons. It was impracticable for large armatures, and a winding made up of separate bobbins or coils, which could readily be removed and replaced, was found to be exceedingly desirable. To meet these requirements, therefore, the method of winding was changed to an arrangement similar to what is generally spoken of in text-books as the " Siemens alternating armature."

It now remains for me, before passing on to the less important apparatus of the Ferranti system, to give a brief description of dynamos which are installed, and being installed, at the Deptford station.

So much has been said and written about these during the past year or more, that I almost hesitate to mention them at all, so sure do I feel that almost every one here is familiar with their general character and dimensions.

The Deptford machines will be of two sizes, the portion of the station to be put into immediate use calling for three dynamos, two of 1,500 horse power each, and one of no less than 10,000. Of these the two first are now installed and running, whilst the 10,000 horse power machine is still in course of construction, it being far too enormous a piece of machinery to admit of hurrying.

Each of the 1,500 horse power machines are driven by means of 40 five inch ropes from a compound vertical condensing engine of marine type, having a grooved drum or driving pulley 24 inches in diameter.

The carrying-arms of the armature, which support the winding, are fixed directly into one end of what may be called at once the pulley and the armature boss by means of sulphur insulation. Into these carrying-arms are the fixed 48 bobbins which constitute the winding. The total diameter of the armature is 12 feet, 6 inches. The fields are arranged as in the smaller machines and have 48 magnets on each side, 95 in all. The copper strip composing the winding of the armature is three-quarters of an inch in width and one-and-a-half millimeters in thickness.

There is only one inch of space between the opposite magnet poles, and within this the armature rotates, having one-eighth inch clearance on each side.

Small fan-shaped ears are cast on to the carrying-arms of these, and the other machines which I have described, which, when the machines are in motion, force a constant current of air between the armature and the field, keeping up a very perfect ventilation, and removing any dust which might accumulate upon the face of the magnets. This dust, if allowed to remain, would be apt to cause a short circuit from winding to magnets, as one pole of the machines is to ground; as an additional precaution against this, the faces of the magnets are covered with a thin layer of vulcanite.

The frame divides as in the smaller machines, and slides back on extension bases to afford access to the armature, a special engine being provided to do this work.

Of the 10,000 horse power dynamo, I can say but little; it will differ from the others only so far as its enormous size renders necessary. The armature will be no less than 40 feet in diameter, and will rotate at a speed of 60 revolutions per minute. It will be coupled direct to two compound vertical condensing engines, each of 5,000 horse power, one on each side of the armature.

The shaft is the largest ever turned out of the celebrated Clyde workshops, and one of the largest ever made in the world. It is no less than 36 inches in diameter, 28 inches in the bearings. I really do not dare to state its weight. There will be 132 bobbins in the armature and 132 magnets on each side. The enormous size of this machine is quite beyond the comprehension of one who has not seen its parts.

The station instruments which are used in connection with the Ferranti dynamo, are the Sir William Thomson gravity direct-reading ammeter and the Sir William Thomson statical voltmeter.

I will now pass on to a brief description of the Ferranti transformer, meter, etc. I am aware that I have been able to give but the merest outline of Ferranti's dynamo construction; the subject is far too intricate and wide a one to be treated at all in detail within the limits of a short paper.

Before describing the Ferranti transformer, I should say a few words about the Ferranti fuse. Its position seems naturally to be between dynamo and transformer. This is an exceedingly simple device of porcelain, having a long break. It consists of two removable plugs, to which are fastened a number of thin strands of fuse wire, according to the current to be carried. These wires pass through a narrow crevice or slot in the earthenware, from plug to plug, the crevice being broken at short intervals by cup-shaped hollows, this construction preventing arcing. The fuse has a convenient earthenware cover, can be placed anywhere, and has always proved entirely trustworthy.

The Ferranti transformer is seemingly as little known as the dynamo in this country. It is a very simple affair, of decidedly high efficiency, consisting of a number of bundles of very thin, soft, hoop iron, spaced apart with wedges, clamped tightly together and wound at their central portion with insulation. Each strip of iron is insulated from its neighbor for half its length on each side, by paper pasted on. This, when the irons are turned back, as I shall presently describe, leaves a strip of paper between each layer of iron, but does not prevent a perfect magnetic circuit.

On these bundles of irons, at the portion wrapped with insulation, is wound the secondary, which is, in its turn, wrapped with insulation; on to all this the primary is slipped, in the shape of a number of coils, wound elsewhere on former blocks. These coils are slipped on, one by one, and separated from one another by washers of shellaced cardboard.

The projecting irons are then turned back over the coils from each end, lapping each other, first one way, then the other, like shuffled cards, and the last two are fastened off by a simple double " L" or tinman's joint. Half of each bundle is turned back in each direction, up and down, forming complete magnetic circuits in two directions.

The transformer is extremely convenient in case of repairs, when the irons are readily straightened out and burnt primary coils replaced. It seems, however, to have several marked defects. The flat side of the lamination is presented to the penetration of the lines of force, which, according to Kennedy, is incorrect construction, and the transformer is inclined for this reason, both to heat rather badly and to hum; the latter trouble being partly due, doubtless, to the fact that the iron cannot be held so firmly in this style of converter as in the more common type, where the iron forms a solid block.

The transformer is incased within a cast-iron shell, from which it is insulated and into which the primary and secondary terminals are fixed by means of the Ferranti sulphur insulation.

These converters are made in five sizes: 25, 50, 100, 150 and 200 lighters. The large transformers, for reducing the 10,000 volts of the primary to the 2,500 volts of the street circuits, are of the same construction as these I have just described, the insulation being, of course, increased to bear the enormous pressure.

This is not the original transformer used by Ferranti; that was of the Gramme ring type and rather more efficient than the present one, I believe, but scarcely practical from a mechanical standpoint.

There now remains to describe only the Ferranti meter, a most ingenious recording instrument largely used in connection with Mr. Ferranti's London circuits. This meter consists of a coil of a few turns, in series with the lamps, which passes around a core of soft iron, and terminates in a composition metal ring, which is split to prevent Foucault currents, and is bolted on to a soft iron base, being, however, insulated from it. Thus it will be seen that the ring, the base, and the soft core around which the coil passes (the lower portion of which is burnt or cast into the ring also), form, respectively, sides, bottom and top of a hollow and tight trough; the iron is continued from above the coil by means of a horseshoe-shaped laminated piece of iron which passes down outside of the coil and makes contact with the base; thus we have a magnetic pole at the top and bottom of the trough.

This trough is filled with mercury, making contact with three-fourths of the inner circumference of the ring, and the center of the base. The current entering the coil, passes around to the ring, and from the ring through the mercury to the base on which is the other terminal.

Under the combined influence of the magnetic field and the current passing through the mercury from center to periphery, and *vice versa*, the quick-silver is caused to rotate.

A shaft passes from a jewel in the base, through a small hole in the iron core to a train of wheels at the top; on this shaft is an aluminum fan suspended in the bath; this is all balanced so nicely that it actually floats in mercury.

Now, since the resistance to rotation due to friction is approximately proportional to the square of the speed, and the turning moment is proportional to the square of the current, the number of revolutions performed in a given time is a measure of the current which has passed through the meter during that period.

Owing, however, to the rule of friction not following this law absolutely, and owing to the additional and irregular friction of the gear, a sensible error is introduced. This difficulty is overcome by placing a shunt coil of high resistance around the series coil, which secures an excess of electro-magnetic action, when the friction is greatest in proportion to the torque, thus assisting the low loads.

The meter is very accurate, and has a quite wide range, 1 to 50 amperes being the capacity of the 100 volt instruments; it is equally serviceable on direct or alternating circuits of any frequency.

This meter, while undoubtedly accurate, has many very apparent weak points, however; the mercury volatilizes quite rapidly, especially when the instrument becomes warm; the meters must always be kept upright or their contents will spill, and they cannot be carried from place to place without being emptied and refilled, which, as the quantity of quick-silver varies, is apt to introduce errors. In view of these troubles, Mr. Ferranti is now also manufacturing and using a number of meters of small capacity, similar in principle to the well-known Shallenberger instrument, which are sufficiently accurate for general use; these are manufactured under the English patents of Mr. Wright, one of Mr. Ferranti's staff.

I would like to say that a gentleman who was associated with Mr. Ferranti at the time I was, and a considerably longer time than I was, is now in America, and I hoped that he would be here to-day. He was at Deptford long after I was and is very well posted on this machine. I thought he would give you some additional information when the paper was over, but I received a telegram from him saying that he could not get here. But there is a very complete article from his pen in *Electrical Industries*, in the last issue, published in Chicago. It is to be continued in the next number, I believe. He is now with the Thomson-Houston Electric Company.

DISCUSSION.

THE PRESIDENT: Gentlemen, you have listened to the paper of Mr. Haskins. It certainly has been a very interesting and instructive one. Have you any remarks, or any questions to ask Mr. Haskins? The paper is open for consideration.

MR. LAW: I would like to ask Mr. Haskins some questions in regard to connecting transformers on to his primary circuit. We, who have been in electric lighting some time, and have been knocked down several times—last time in a pond of water ten inches deep and filled with ice—do not like to receive those currents. Now, to do successful commercial lighting we are obliged, in order to compete with gas, to keep a continuous service on our primary circuits. I would like to ask Mr. Haskins what provision they make for connecting converter wires on to his primary mains.

Mr. Haskins: Mr. Ferranti has, I believe, four or five methods in use for connecting on to his concentric mains. The commonest thing is a good deal like the brace that a plumber would put into a pipe. He brings out the inner tube through a sort of T joint and carries it a good distance before the insulation is removed from it. That gives him one leg of the circuit. The other is taken off by an outside ring which is soldered on to the other conductor and goes in the other direction, for a safe distance, covered by insulation. That, I think is the method that will be practiced most generally. You will understand that the circuit is only taken off at four places, at the four central distributing stations, where the current is reduced to 2,500 volts, and then distributed for house lighting. The current which goes to the houses is secondary, not primary.

Judge Armstrong: So, if you got a shock, it would be only 2,500 volts instead of 10,000?

Mr. Law: What arrangement do you make for connecting on to a 2,500 volt circuit? Even taking a thousand volt circuit and attempting to make a connection on a wet day is rather a hot process.

Mr. Haskins: Yes, sir; it is. It is not intended that any connection shall be made while the circuit is alive. Of course, it would be in this way—if a store was to be connected on, they would take the time to connect that on when that portion of the circuit was not in use. That is the method that Mr. Ferranti has always followed. They do not attempt to handle the 2,500 volt wires when they are alive. I have handled them myself when they are alive, and I have handled 10,000 volts when it is alive, too, but I do not like to.

MR. LAW: As I said before, Mr. President, we have to burn lights continuously. The current has to be on that light for 24 hours in the day, unless you make an auxiliary line for it, which the expense would prevent us from doing. Now, we have to connect our converters on the live wires, and we cannot wait just because it happens to be a little bit stormy. That storm may continue for two or three or four days. As I say, it is almost impossible to connect on a thousand volt current under those circumstances, and I wish to find out what arrangement has been made for connecting on this higher voltage without danger to the man doing it.

MR. HASKINS: Where it is found necessary to connect on where the circuit is alive, they take out the double plug fuse on the primary. The fuse can be put in with safety when the current is alive. That is the primary tube.

MR. SEELY: I would like to state, in response to the inquiry of the gentleman from Philadelphia, that the Manhattan Electric Light Company, of New York City, have an ingenious way of connecting from the primary to the converters. They place the primaries in front of their houses into binding posts, and those binding posts are insulated. In case a subscriber is put in, they put in what they call a primary switch, and after the insulation is made and the lamps installed, all that is necessary is to close a switch. They have also interposed those switches into all their lines now, as the Fire Underwriters have requested it.

MR. LAW: I may be a little thick-headed, but I do not get at just what I wanted to know, and that is, how they make the attachments directly to the primary mains. I have done it, connecting converters by using a plug or a switch, but the trick comes in putting the leg on to the primary main to get at this plug or switch, or binding post, whatever you use. What I want to know is, how we can connect that primary loop to the converter on to the main of the primary and not get the shock that we are liable to get, provided those lines have a little leaking.

MR. SEELY: I would not advise any one to attempt to make a connection to the primary with a thousand volts. It is a well known fact that it is being done every day by legging on to the primary with rubber boots, rubber gloves, etc., but I know of no well known means by which you can avoid receiving a shock if the poles happen to be damp or you are standing on the sidewalk. They do handle some very high tension currents in New York City, and I do not think we have had any deaths to the present time, but it is only a question of time.

MR. HASKINS: I might say that during my connection with Mr. Ferranti, although we were running a very large circuit from the Grosvenor Gallery, we had only one death in connection with the system, and that man was killed by being carried around the pulley by the rope gearings, so that the 2,500 volts was not responsible for that. It is not Mr. Ferranti's intention that the wire should ever be tapped into when alive. Mr. Ferranti does not keep his wires alive constantly. He generally opens each circuit for about half an hour every day. I have known them to be open for a little longer than that.

MR. BRADLEY, of Fort Wayne: I would like to ask Mr. Haskins what is the rate of alternation—how many periods per second? What is the standard?

MR. HASKINS: I cannot tell you what the rate of alternation is. I do not know. I might have figured it out if I had thought to do so, but I did not.

MR. BRADLEY: I find, according to the number of pole pieces and the rate of steam, that the small machine is about 11,000 reversals.

MR. HASKINS: Yes, sir.

MR. BRADLEY: Per minute, and the larger one is only about 7,900—something like that. I should think that no two machines could be placed on the same system so far apart.

MR. HASKINS: You mean two machines could not be placed in multiple.

MR. BRADLEY: No, used first one then the other, because the transformers have to be planned according to a certain rate.

MR. LAW: You found that difference in frequency between the 1,500 horse power machine and the 10,000 horse power machine.

MR. BRADLEY: As I understand you, 40 pole pieces and 280 revolutions for the smaller machine, 60 revolutions and 132 pole pieces for the large machines.

MR. HASKINS: It is possible that I have erred in regard to the speed of the smaller machine. The frequency on both machines is the same. If there is an error, it is undoubtedly in the speed of the smaller machine.

I find that I have not given the speed of rotation in the 1,500 horse power machines. I gave the rate of rotation on the Grosvenor Gallery machine of 625 horse power, and I gave the rate of rotation of the 10,000 horse power machine. The frequency of the 10,000 horse power and the 1,500 horse power machines would be the same.

THE PRESIDENT: Are there any further remarks on the subject of Mr. Haskins' paper? If not, we will proceed to the consideration of the next item on the programme.

MR. PERRINE: Mr. President, some of the gentlemen present might be interested in rope gearing, and I though I would mention that there is a very excellent system of rope gearing in use in this city, on the Cable road, at the power house, which I have no doubt there would be no objection to the members seeing if they should care to go over there.

MR. HASKINS: In that connection, I should like to ask the gentleman what kind of rope they use?

MR. PERRINE: I do not know, I never saw it until yesterday, but I think they use cotton rope.

THE PRESIDENT: I can state about that. They use manilla rope.

MR. POPE: Mr. President, Mr. Walter B. Phillips, an old journalist of Providence, said he once thought that one of the unsatisfactory things about journals was, that they sent stuff broadcast through the world, and you never knew whether it was appreciated or not. In view of that I wish to offer the following resolution:

RESOLUTION OF THANKS TO DAILY PRESS.

"*Resolved*, That the sincere thanks of the National Electric Light Association be tendered to the publishers and staff of the Providence *Journal*, Providence *Bulletin*, Providence *Telegram*, Boston *Herald* and Boston *Globe* for the very complete and accurate reports of the proceedings of the Thirteenth Convention that have appeared during its sessions in Providence, February 17 to 19, 1891." (Applause.)

The resolution was seconded and unanimously adopted.

THE PRESIDENT: We will now listen to a paper by T. Carpenter Smith, on "Distribution and Care of Alternating Currents."

DISTRIBUTION AND CARE OF ALTERNATING CURRENTS.

GENTLEMEN: After Mr. Haskins' very interesting description of the English practice, I feel a hesitation in saying anything about our own practice, as it seems to be on a so much smaller scale; but, I think, we make up in the number of plants what they have gained in the size of the few plants that they have in operation.

I feel some reluctance in speaking upon this subject at all, because I have already spoken upon it at two or three Conventions; but it has been brought to my notice that while a good deal of it is an old story to some of us, there are new stations starting up every day, and it is to these people that I address myself more particularly. I want to keep them from falling into the same holes that we fell into, and I do not think there is anything that has hurt the business more than the failures in it—I do not mean the practical or the working failures, but the commercial failures. The men who put their money into those original plants, without any knowledge, and who did it on the faith of their engineers, and who found that they did not get a sufficient return from it, are not only loath to spend any more money themselves, but they exercise a very bad effect on others when they try to influence new capital.

I will begin by stating that there are a great many points covered in the care of the alternating currents as used for electric lighting that apply with equal force to all others at present in use for commercial purposes. It is always the unexpected that happens, and, no doubt, many points arise in practice which are never known outside of the station in which they occur, being treated as matters of course. If, therefore, I seem to omit any point which should be covered, it must be remembered that it is my intention, as much as possible, to avoid recapitulation in such cases, but only describe some peculiarities of alternating current distribution which render certain precautions especially necessary and valuable.

To more easily arrive at these it will be well, however, to briefly state the different forms of electrical currents now in commercial use, and what we may call the governing characteristic of each. I leave out those which come first in the history of the question ; namely, telegraph, telephone, district call and fire alarm current. They are only worthy of note for their generally poor installation (laughter), the telephone lines especially being a perpetual nuisance to all of the others. This arises chiefly from their being of such light gauges of wire that they will not stand any exceptional strain, such as is placed upon them by sleet storms or heavy gales, while the effect of rust and deterioration from atmospheric causes rapidly reduces them to the point beyond which they will not carry their own weight. I need not say that the moment they fall upon any electric light or power wires they become a menace not only to the company operating the wires on which they fall, but themselves become dangerous to passers-by in the streets who have not yet learned that any dangling wire is worthy of avoidance.

Perhaps the strongest reasons why these wires are present in such overwhelming numbers in most cities is the fact that their value as "scrap" material will not pay the cost of taking them down. In other words, a short-sighted policy decides that it is cheaper to leave them up, and they are abandoned until they either fall down or are taken down by some other company which has reason to fear them.

The first that we consider of the currents now in general use from central stations are the "arc lighting circuits." To take the most powerful current generally operated on this system we place it at about 10 amperes, and from 2,500 to 3,000 volts on a single wire. In this current we have, as a rule, the governing characteristic of a very high tension, but with small volume; and it may be well to note the particular form of danger to which it gives rise. Its high tension makes it dangerous both as to life and fire, from its liability to leap through the insulation, when the current has once been started to form a long arc. On the other hand, the danger is limited by the fact that the volume of current is small, and that the short circuiting of the line by any other conductor tends, as a rule, to simply cut the lights out, rather than to cause any great danger at the point where this happens, while nearly all the machinery of this type in general use automatically reduces the energy at once.

The chief points to be guarded in these currents are, therefore, practically covered by the general precautions of good insulation and protection against leakage by moisture reaching the wires, while the danger to life is very largely eliminated by the usual practice of placing all lamps and appliances well out of reach of the public, and confining their care entirely to employees who are presumably skilled, and who will therefore handle the matter intelligently.

In the second great division of electrical currents which we consider, the "Low Tension Direct Current" system, the ruling feature is the large quantity. We may say that this current is practically not dangerous to life, but very dangerous as regard fire if not properly installed and protected. It is, however, a simple matter to properly protect these wires and the low tension not putting any great strain on insulation, we may discuss it as fully covered by the ordinary rule of the Fire Insurance Underwriters, who, in this respect, owing to the nature of the business, have even more interest in the saving of property from fire than the central station itself. The great danger, however, lies in the fact that the volume of current is so great that any short circuit on the main lines developed an enormous amount of energy at the point of accident, sufficient—on the authority of Mr. Edison himself—to reduce the pavement to a molten mass for many feet. (Laughter.) The general public also must necessarily have considerable care and control of the distributive appliances, and in their ignorance will often put grounds on the wires, or replace fusible plugs by copper wires; and this all has to be watched for.

And that is a danger that I think central stations ought to interest themselves more in. In Philadelphia, we have got to a very good point with the underwriters, and they keep inspectors constantly at work; they do not merely inspect the work when it is being put in, but they go to a man's building at odd times and look over his wiring again, and if they find any such foolishness as copper replacing fuses they will very often order his lights to be taken out; and it has only taken one or two instances of that kind to awaken the public to the fact that there are rights which the central station has and there are certain precautions which they themselves must take.

The third great branch, and the one with which we more particularly concern ourselves to-day, is comparatively a new one, but has, in the short time it has been in existence, had so phenomenal a growth that it is no wonder that we find even the commonest precautions oftentimes neglected in its use.

In the "alternating" or "converter" system we may say at once, as regards the secondary distribution, *i. e.*, from the converter to the lamp, that the rules already laid down for the installation of low tension direct current wires will practically cover the case. The alternating current of fifty volts, which practically is the standard to-day, will work successfully with insulation and under conditions which would lead to trouble immediately with even the one hundred volts direct current; and this fact in itself often leads to poor work, either from intention or ignorance. The wiring, of course, must be proportionately heavier for this current than for the direct, which perhaps adds some slight risk, an under-sized wire being used; but this is an evil which will generally correct itself owing to the diminution in light making itself felt before the danger point is reached. The fact also that the converter cuts off all connection between the customer and the company removes the great danger of grounds on one building affecting the whole system.

There are certain peculiar features, however, which should not be overlooked; namely, that moisture will often cause sufficient leak in any way of a short circuit to heavily overload the wires, while not sufficient to start the "dead" short circuit, which would blow the fuses. For this reason, special care should be taken that the wires are properly "fused," and that in the event of a fuse persistently blowing with only its proper number of lamps, search should be made for leaks.

The general tendency in the electric light business being now very largely to make the consumer responsibie for all the wire upon his own premises beyond the converter, narrows the subject down to that on which I wish more particularly to speak—"High Tension Alternating Current Distribution." This current has, to a certain extent, the governing characteristics of both those mentioned above, and this has excited a disproportionate fear of it. Its tension of 1,000 volts (to take that oftenest used) is high enough to make a first-class insulation necessary as a precaution against leaks, which may soon break out altogether, and its being a constant potential system allows the whole power of the dynamo, or rather of the engine driving it, to be possibly developed at any point of a short circuit.

Without going into the fiercely debated question of direct *vs.* "alternating" currents, I would call attention to one fact. With high tension "direct" currents I have linemen, in repairing lines or cutting in circuits, handle an arc circuit of perhaps 2,000 volts when they could hardly touch it, and by taking a quick hold and keeping it, make a connection while really in a position of great danger, since a ground coming on the line elsewhere would surely kill or injure them, though they would not believe this since they could only feel the current at the moment of taking hold or letting go. With the alternating, however, the effect is constant, and so intensely disagreeable that a very slight leak, indeed, will discourage any one from running the least risk on live circuits. I may mention in this connection that as far as my experience goes (and I believe some of the learned doctors agree with me), the action of a heavy shock of alternating current is to force the diaphragm upon the chest, compressing the lungs, and literally squeezing the breath out of one, causing the cry which seems peculiar to those caught in this way. If the person is stunned, dash cold water on the face and chest, loosen the clothing, especially at the neck, and use artificial respiration, as for the drowned. One of our linemen, who was badly caught, was brought round by these means, after being, to all intents and purposes, dead for nearly ten minutes, no breath or pulse being visible.

Coming now to my subject proper, the first precaution which I think we should take in any case is to properly lay out a system of distribution according to the circumstances of the installation. Almost the first point to be thoroughly settled is the size of unit dynamo which it is proposed to use. This should be kept as large as possible for the reason that, practically, a large dynamo takes no more care to look after than a small one, while at the same time care must be taken not to get it too large, since an underloaded dynamo and engine is not economical to run.

The second point is, that as alternating current dynamos are easiest to run separately and not in multiple arc, the planning of the pole-lines, feeders and mains for the various circuits should be such that these units can be economically used.

Another point to be looked at in the general plan is that wherever possible the sizes of mains and feeders should be kept the same throughout, thus reducing the number of sizes of wire used in street work, and keeping the pole lines and fittings as uniform as possible.

It is astonishing how few different sizes of wire are really needed if care be used in planning, for it is always a good fault to keep the sizes up, both for mechanical and electrical reasons.

It must not be forgotten that, however much we may be able at the present, or have been able in the past, to control the condition under which we shall supply the public with any article, it is only a question of time when the public will decide for themselves, not only under what conditions, but in what quantities and under what prices they will take what we have to supply.

In the early history of electric lighting, and we may say even to the present time, as far as arc lighting is concerned, the contract basis will be the one upon which the light is sold. With incandescent lighting, for many years the contract system seemed to be the basis, but as soon as a good and reliable meter was placed upon the market, that moment the conditions were changed.

It is a part of our human nature to desire only to pay for that which we use, and it is equally part of our human nature to try and get something which we have not paid for, and for this reason there will always be those who desire the meter system and those who desire the contract system, but the weight of public opinion is so heavily in favor of the meter system that we may, to all intents and purposes, consider it as the adopted method of sale.

Electric lighting is after all only a lighting business, and those who are concerned in the furnishing of incandescent electric lights will learn many a valuable lesson from the gas companies, who, as I have more than once reminded you at these conventions, did not reach their present methods and conditions by having them schemed out at the start, but through much tribulation and many trials, so that their present methods are simply another instance of the survival of the fittest. For these reasons, in deciding on unit sizes, remember to count on probable load and not on probable number of lights rented.

To begin with the dynamos, we may say that the best unit to use will be probably found by taking the maximum all day load. In some cases, however, this will be very light compared to the loads thrown on during the "heavy hours," and in such cases it may be better to use a much larger machine for the sake of uniformity with its many advantages. If multiples of a unit are used, only one or two square parts need be carried, the feeders and mains can all be laid out alike, and any dynamo is ready to take the place of any other without any preliminary cutting and changing of circuits.

The question of sub-divided power is a vexed one, and one in which we can never hope to see all agree, and I therefore do not make any suggestions beyond noting that a dynamo which can pull up its driving engine without injury to itself is a good thing; that running a small engine as a relay is cheaper than running a large one, and that in incandescent lighting the customer, not the central station, regulates the load. Of course these remarks apply only to engines of the same type. I do not set a small high speed single expansion engine against a large compound or triple expansion one.

Keep dynamos well insulated, but put collectors to lead off static electricity from the bolts. If there is a slight leak on one of your circuits, the easiest path for the spark may be to jump into the armature and so to line the ground, and this spark will punch through almost any insulation, and gradually keep making it weaker till some day the the current generated in the armature follows the spark and your armature is gone.

Look carefully to all screws and bolts; the alternating current seems to have some peculiar effect (perhaps by mechanical vibration, perhaps by actual molecular expansion and contraction), in loosening screws, causing small arcs which may melt off connections, or may make bad contacts. Nothing is more annoying than to have a dynamo operating perfectly until shut down, and then refusing to start up again. This comes often from such poor contacts, the current following and bridging over as long as it is kept going, but failing to make the first jump necessary to start. In arc lighting machinery this used to be got over by "jumping the machine" or short-circuiting it for an instant; and I have known alternating incandescent dynamos ruined by being served the same way.

A small air pump and tank with lines of pipe through the station and a hose to direct a strong jet of air into the armatures will be found a valuable addition to station equipment, and the amount of dust and copper which can be blown out after the hand bellows has done its best, is surprising.

Have your switchboard so that circuits and dynamos can be easily and quickly changed.

One feature which Ferranti seems to have early foreseen, and that is a feature which in our American practice, I think, has been somewhat neglected, is the use of fuses with a very much greater distance between the points of attachment, and some ready means of replacing these fuses without danger to the person so doing, even if a short circuit should still exist on the line which is being handled.

For this reason also it is a great mistake to crowd switchboards too closely. There could be abundant room given both for the operator to stand in front of the board and to beat a hasty retreat, without the danger of being caught by machinery or bolts behind him, and to allow the free use of the hands and arms without the danger of being burnt by fuses in the immediate neighborhood, which may go off at any time. While an alternating current will not make much of an arc when a fuse melts simply from overload, it does make a wicked and demoralizing one when a short circuit is present, especially when it has a heavy machine behind it.

There will always be some hesitation, I think, as to the adoption of devices for putting in fuses which do not have a positive contact, such as a screw connection, or one which I think Ferranti used, a plug which can be twisted in at every application, thereby keeping the contacts clean. I think, however, that we shall soon see a fuse adopted which shall be in the form of a switch which can be opened and closed as often as needed to keep contacts bright and clean.

In fitting up the fuse blocks and switchboards it is as well to leave no points or sharp corners exposed, since the alternating current will jump from such points if it be trained across or induced to do so by the presence of the lead vapor from a fuse which has blown.

It was one of my earliest experiences to see an arc jump in this way, from the ends of wires which had been pushed so far through the connections on switches as to show their ragged points beyond the metal of the switch. The arc which was formed on a blowing out of a high tension fuse bridged between two such points, a distance of nearly 10 inches and held there for some 15 or 20 seconds, in which time it had pretty thoroughly melted up the brass parts of the switches. In this case the arc had been started by throwing in a 100,000 watt dynamo on a short circuit.

While high insulation is needed on a switchboard, which leads many to the use of rubber wire, I would say that I think a far greater danger is introduced by its use, namely, fire. On an incandescent board, fuses may go at any moment and draw a heavy arc with them. If coverings and fittings be used which will not carry flame, all is clear for new fuses in a few seconds; but if fire once starts and the other fuses let go, there is no saying where the damage will stop. While the voltage was enormously higher, and we do not know under how much more difficult conditions they labored, the destruction of a switchboard in the Grosvenor Gallery Station, in London, and the consequent shutting down of 30,000 lights, is a warning which all should heed.

It is always best to have no wires concealed anywhere about a station, and they should be run on porcelain or glass insulators so as to be perfectly safe from fire even if they should be soaking wet. With wires running this way there need be no fear of throwing water on wood work which is in danger of catching fire, since the worst damage that can be done would be the blowing of the fuses from a short circuit. Of course, the covering of the wires should be of a kind which will properly protect those who are working among them. A separate ammeter and voltmeter on each circuit or feeder, while apparently an expensive luxury, is in reality a very great saving and convenience in a station which has lines over a half mile in length. The ammeter enables one to tell precisely on what feeders the load is heaviest ; and where more than one feeder runs to any district, it is a convenient means of knowing just upon what circuit to cut in the lights for any new customer. If the system in use allows any compensating device for indicating the correct voltage at the point of distribution, instead of in the station, it will be so much the better ; and also to have on all feeders if possible, but certainly on extended ones, some arrangement for raising the electromotive force, in order that both short and long feeders may be operated from the same dynamo. Of course, there are many cases where it pays to run a separate dynamo at higher voltage for a particular feeder or set of feeders on which there is a heavy drop. But even in such cases it is often useful to be able to run these feeders with those on which the drop is small from the same dynamo.

Put pilot lamps on each feeder, which will often attract attention to a circuit being out quicker than the voltmeter, and put pilot lamps also on each field circuit.

If separately excited dynamos are used, put pilot lamps also on both the main circuit and field circuit of the exciters. These pilot lamps need not, of course, be up to candle power; high resistance lamps or lamps placed in series will be quite sufficient, and the amount of current they use inappreciable, while the saving in time which the lamps afford in case of any failure of current, enabling an attendant to locate the trouble at once between certain points, is often considerable. Thus, if the pilot lamps on the main feeder and on the field circuit of the alternator have both gone out while the pilot lamps on the exciter mains and exciter fields are still lit, it shows that the trouble is somewhere between the pilot lamps on the field circuit and the exciter mains, being probably loose contacts in the switches, or something of that kind. If the pilot lamps of the alternator only have gone out there is no use looking for any trouble about the fields or the exciter circuits, since the pilot lamps being lit there shows at once that the trouble is further on in the chain of connections. It may seem a refinement to put in such arrangements for the sake of saving a few minutes or even seconds in locating troubles; but it must be remembered that the public are more and more demanding that incandescent lighting shall be as continuous and reliable as any other method, and when all the lights in a building go out at once, a few seconds delay may be a very serious matter. The public are not concerned with what the cause of the trouble may be, but only have one question "Why do I not get the light that I pay for?" and the man who rents one light is often more troublesome than the man who rents a thousand.

Separate exciting, I think, will be found to give the easiest handling of dynamos, and also has the advantage that as long as the alternators each have their independent rheostat, the regulation of the exciting current regulates all the lights with very little trouble.

For small stations self-exciting machines have their advantage since it gives less actual machines to look after; but I doubt whether this advantage is not more than covered by the fact that it is a simple matter to carry a spare armature for the small exciter, which can be slipped out in a few minutes, rather than to have to change the heavy armature of an alternator because of some slight trouble with its exciting coils or commutator.

While alternating current dynamos are best run separately and the need of synchronizing is not often felt, when it is wanted it is wanted badly; and it is a good plan to carefully speed all machines and engines so that they will all run at one speed when light, and at a certain increased speed when loaded. This can generally be done with separate engines by changing the governors, and, where shafting is used, by slight changes in pulley diameters, and this will enable the dynamos to be run together if required, with as little trouble or danger as may be.

The keeping of a careful log in boiler, engine and dynamo rooms I need hardly refer to. For some years now in the larger and better equipped stations it has been customary to weigh the coal used under the boilers and to keep an hourly or half-hourly record of the load upon each dynamo and feeder. Now that reliable meters can be had for use on high tension circuits, I think it would be a matter of the greatest importance to have one of these placed in the circuit of each separate feeder, since by that means we are enabled to check up the difference between the amount of current furnished to the feeder at the station each month, and the amount of current which is charged to the various customers on that same feeder. There is something more than the station meter of the gas company, and its value as a means of detecting leakage on the lines, whether from bad insulation or from theft of current, cannot be overestimated.

One point we must always keep clear before us, and that is, that as long as the contract condition of selling light existed, the cost of making this light did not bear so unvariable and fixed a value with reference to the profits of the station as it does where a meter is used.

With the contract system there might be many contracts made for the use of a certain amount of light, which amount of light would not be used, resulting in a direct profit to the company, which in such cases received money for what it did not furnish; but with the meter system the only receipts of the company are for the current which is delivered to the customer per watt hour, and the cost of producing this current per watt hour is the measure of success or failure.

It is, I suppose, hardly necessary to refer to the advantages of keeping careful records of dynamos and converters and all repairs to same. The advantage of such a system of records can only be appreciated by those who have used it. There are certain classes of machines in which armatures will last without giving a sign of trouble for from two to three years, and then one coil after another will commence giving out. It may be found that when a machine has been running for perhaps a few months and a coil gives away, that this coil may have given out from some local defect or injury in itself, and it will be worth while to repair only this coil. On the other hand, if at the end of four years a coil gives out, and then a month or two later another coil, it may pay better to rewind the whole armature than to do any patching, since the chances are that the whole armature is weakened and will keep on breaking down until the whole has been rewound anyhow. The same with converters; there will occasionally be found a converter which is always in trouble. It may keep blowing fuses or burning out switchboards continuously, and in a short time the extra cost of taking care of it would soon amount to more than a complete repair.

I do not mean to include in the regular repair book such small items as the placing of fuses; but it is astonishing how much can be learned about converters by persistently following them up. The meters which are now in general use cannot be too carefully watched. There are numerous little troubles which arise with them, chiefly from poor contacts and dust. By keeping a careful record from month to month a great deal may be learned about them, and some of the apparently unaccountable changes in their records traced up.

Among some of the minor points which must be looked out for are, first, to see that spiders and insects do not get into them and stop their motion, and, secondly, that the growth of electrical knowledge among the customers does not extend to make them try to beat the meter. We have found cases where this was done by drilling a very fine hole in the case of the meter and dropping into it a fine wire which should touch the vanes and so stop the meter recording, this being done for perhaps two weeks in the month, so as not to arouse suspicion by a total cessation of the record, while at the same time allowing a wide interval of time during which the meter inspector might make his rounds without detecting the presence of this wire.

The short circuiting of a meter has been practiced to some extent, but this can usually be guarded against by running both wires to the meter under mouldings, which, as a rule, the customer does not care to meddle with. In one type of meter we have seen large pieces of iron placed beside it to interfere with its record, and this will affect almost any mechanical meter. The electric meter being, as a rule, placed like its cousin, the gas meter, in the darkest and most inaccessible spot in the building, is not always easy to keep closely watched, but if it is, a few good examples will often do away with a large measure of trouble.

To take up the second great branch of my subject, that of the "Outside Distribution," let us return to the point where we spoke of the importance of outlining the plan and layout of the circuits in connection with the decision of unit dynamo.

For the outside distribution, the first point that we have to consider is the question as to whether the wires are to be run overhead or underground. Without expressing any preference for one or the other, I would mention a few points in each which should be carefully looked after before deciding upon the use of either. If underground work be possible, what advantage do we gain by its use? We may say that we practically get rid of all of the trouble connected with storms and fires and other incidents of like nature. We also remove a great deal of the public clamor against the use of electricity, and we avoid the annoying interruption to work which goes on from the mere fact that our operations have to be conducted in full sight on the public streets. We also, to a certain extent, get a kind of claim upon premises where the current has been introduced underground, since, as a rule, the connections are not visible from the outside; and when the current has been cut off we are not required to remove them, as is often the case with overhead wires. All things considered, the maintenance of underground cables would probably be less than that of overhead wires, providing that the fixed charges due to the enormously increased cost be left out, since accidents to overhead lines generally occur altogether from storms, etc., compelling the carrying of a larger force of wiremen, or a proportionately longer time to make repairs.

The greatest disadvantages of underground wires are undoubtedly the uncertainty as to their life, both from want of experience and from ignorance of the exact causes which lead to their destruction; and also that their enormous first cost raises the cost of the production of the electric light to a point which compels us to charge the public more for their light than they are inclined to give, which fact, in many cases, actually prohibits its introduction. A very peculiar series of phenomena are introduced when wires are placed underground in such close proximity to one another, as they necessarily must where a large number are run in a conduit together, and these results are not very well understood so far even by those who have had the most experience with them. I may cite as an instance of this the effect which has been observed in Mr. Ferranti's 10,000 volt mains from the Deptford station, where the electromotive force at the London end is higher than that at the generating station. There seems to be some doubt as to what causes this condition, and so far some controversy over it; though it would appear from recent utterances to be fairly well proved that it is due to static capacity, one thing seems certain that a similar effect has been observed on some overhead lines; but in the latter case it has not been sufficient to interfere with good running.

If the overhead system be determined upon, nothing but the very best construction should be used. It must not be forgotten that the majority of accidents which have occurred from overhead wires, have nearly all been caused by poor construction. I do not think I am far wrong if I say that all accidents which have occurred, to others than employees of the companies, have been caused either by poor construction or gross carelessness on the part of those injured. With employees the case is somewhat different. Undoubtedly many have been killed by their own carelessness; but there is a certain class of accidents which occur to the most skilled men and under the most extraordinary conditions, which must be set down simply as true "accidents," and against which no better provision can be made than by careful construction and inspection.

I think I will detail the method which was followed in laying out the feeders for a large central station, as a modification of this will be probably found in most cases.

The bulk of the lighting was expected to be on two main streets of the town, running parallel with one another on a long curve for about a mile and a half, and the central station was located about half-way between the center and end of this line, and about one-half mile distant from the nearest of the two streets. There were five cross streets available, running from the central station in almost a straight line to different points of the main lighting district, and the question was raised as to which would be the best to use for running the main feeders. Approximate calculations showed that the full load of the largest machine proposed, 3,000 lights, could be carried between any two of these cross streets or feeder junctions with the maximum drop proposed if No. 3 wire were used for the mains. It was therefore decided to use a No. 3 wire continuous from end to end for the mains to start with, proper arrangement being made to cut this main into sections as fast as the load should increase, so as to render the splitting up of the load on to one or more machines necessary.

To determine the size of feeders the only point raised was as to which was the heaviest wire which could be run upon poles and handled easily. It was determined that No. o Brown & Sharpe would best fill the conditions, and five lines of No. o Brown & Sharpe wire, on each street, were run up and tapped into the mains at the junctions of both streets. The maximum number of amperes that could be carried by each feeder with two per cent. loss was then calculated and marked on the feeder at the switchboard and on the plans, thus: No. 1 feeder being the longest would only carry 22 amperes; No. 2 feeder would carry 40 amperes; No. 3 feeder would carry 80 amperes; No. 4 feeder would carry 65 amperes; and No. 5 feeder would carry 30 amperes. These would all run the one switchboard, and as soon as the ammeter on any one of these feeders showed that the maximum load during the night's run reached its limit, a second No. o wire would be run on this pole line and multipled with the first, doubling the capacity of the feeder at once. In the same watt, as long as the total load on all of the feeders did not reach above the first 3,000 light machine installed, the mains were left continuous; but as soon as this limit was reached the mains were cut at such a point as to about divide the load into two (2) parts, and two machines were started.

This progress will be kept up indefinitely, the feeders being always kept below two per cent. loss and the mains cut to accommodate the unit of 3,000 lights of dynamo capacity.

The feeder which had the smallest available load, No. 1, carrying 22 amperes, happens to be the feeder which run into the district where the fewest lights are expected, and in all probability will never be doubled up, the district being thinly populated and with no immediate prospect of its being built up very much.

In this plant another detail was introduced of making the breaks in the mains by means of switches, so that in the event of a breakdown of a feeder line the closing of these switches would enable the lights to be taken care of by the machine on either side.

The plan, in fact, makes the whole system of mains one large switchboard, allowing for the transfer of lights up and down the line among the different sections.

In laying out long feeders, try and keep those which belong to different circuits as far apart as possible, since wires which run parallel with each other for long distances will cause interference, especially if the voltage of one circuit be considerably higher than that of the other, and still more if the static capacity of one be much larger. In putting in new lines be very careful to avoid the effects of induction from live circuits, which sometimes rises to an unexpected degree. I have known of a case where men received a heavy enough shock to throw them down in taking hold of the bare end of a wire totally disconnected in every way from the circuit, but which ran parallel for about half a mile with a 1,000 volt feeder. Had these men been handling a bare end on an iron pole they might have received shock enough to throw them down, and injure them seriously from the fall, when we should have had another "mysterious accident" with electricity. In placing converters, while in many cases they can be placed with perfect safety inside of buildings, they can be placed outside in positions where they can be got at easily for re-fusing and without disfiguring the buildings to any extent. A very good rule is to allow no porcelain insulators on out-door work; nothing but glass put on iron brackets so made that the glass can always stand upright to prevent filling with water. No loops should be allowed to be cut in on the circuits between poles, but all connections should be made at a pole. And in the case of converters placed inside buildings, a double pole switch should be placed at this point, though I should not think it absolutely necessary in the case of converters placed outside of buildings.

Run converters separately as much as possible, and if it is absolutely necessary to run them in multiple arc, keep a close watch upon the fuses, since when run in this way converters have a trick of blowing fuses without any apparent cause. Never change high tension fuse.

When converters are brought back to the station for storage they should be kept in a warm dry room to prevent the condensation of moisture on the interior of the cases, which will damage them quicker than leaving them in service out of doors.

It must not be forgotten that the thoroughly sound overhead construction is the strongest argument which can be advanced to-day against companies being compelled to spend large sums of money on underground work. I have been so much interested in the pole-line work done in this city, that I have examined it with some little care, and I find some points that surprise me, though I was well aware that their construction was of the best, and I relate some of these points for your consideration. All new poles are made of sawed yellow pine, tarred, where sunk in the ground, and painted above it. No less than eight inches square being used anywhere and the majority being 10 and 12 inches.

The cross-arms are not only heavy in themselves, but are rendered even more so by the kind of pins used. These are not of wood, but are made by placing a lag bolt with its head in the glass insulator and cementing it in solid with plaster of paris ; these lag bolts being then screwed directly into the cross-arms, avoiding the weakening of the arm by large holes bored into it and doing away with snapping pins.

All new wire strung is of high grade insulation, and all low grade wires, wherever taken down, are re-insulated with high grade insulation before being re-placed. All joints in the line are soldered, and nothing but iron brackets and glass insulators allowed for outside work. Not only have the iron brackets been made for all situations, but they have been made in pairs, so that the leading wires shall always be kept a uniform distance apart, which adds enormously to the trim and workmanlike appearance of the lines. I think all will agree with me that those who are willing to spend the enormous sums that such work costs have established a right to ask that they be not expected to do anything in the way of underground work until underground work has been demonstrated as successful in every way as the work that they have done here, and more than this, that such underground work shall possess decided advantages to compensate for the increased difficulty of locating and correcting trouble, in which respect the overhead line is undoubtedly far superior.

If municipalities wish to place themselves in the front rank of progress, and at the same time encourage local industries, let them rather expend their energies in insisting on and compelling the proper carrying out of well tested methods of construction, than in demanding that untried principles and methods be experimented with, often under conditions which preclude their success. (Applause.)

DISCUSSION.

Dr. Mason: You refer to the practice in Great Britain, of placing converters on the inside of buildings.

I remember Mr. Musgrave told me he would not permit them to be outside of the buildings.

MR. SMITH: There is one reason for that. I was very much surprised in reading over some of the Board of Trade rules in England that converters must be enclosed in a tight wooden case or something of that kind, and we now find that the English practice is not to put the converter as sold by the company in an iron shell. In the Ferranti converter in actual practice, as Mr. Haskins has described it, it would appear that the laminated iron is exposed, except when the converter is specially enclosed. Now, all the converters I have seen of American manufacture have had that outside shell entirely separated from the laminated iron, forming no part of the electrical equipment of the converter, but simply a mechanical protection outside. They come to us from the manufacturer with the case provided. The water would very soon destroy the European converters without that outside case.

DR. MASON: I would like to know from Mr. Haskins whether they have had any case of serious trouble with their method of installation in Great Britain, that is, putting the converters in buildings. I could not see that any special method was used as to placing them. I found them up stairs in the cupola, down-stairs in the cellar, in entries—wherever it seemed most convenient to place them. But I know there is a great objection here. Almost everywhere, except in Philadelphia, it is forbidden that they should be inside any building. I would like to know if there has ever been any trouble resulting from the presence of a converter within a building.

MR. HASKINS: To my knowledge there has been no trouble whatever with transformers in buildings. I think our practice was almost invariably to put the transformer in the cellar, which does not seem like a very favorable place. I have here a number of photographs of transformers, installed and in use. I have photographs of the transformers in Marlborough House, the Prince of Wales' residence, and in several other prominent houses, and I know of no one case where we have had any trouble with our transformers. As Mr. Smith has said, the Ferranti transformer is not entirely enclosed. About two-thirds of the lamination is enclosed. But the internal insulation of the transformer is very perfect and the wiring has to be done in the regulation manner inside.

DR. MASON: I cannot quite understand, if there has never been any trouble from a transformer in a building in one city, why elsewhere they should be absolutely forbidden; but I cast that out and only to call attention to it.

THE PRESIDENT: I think I can answer the question. When we first introduced the system here we had a long talk with Captain Brophy about it. He was the supreme power. He said there was no reason why the converter should not be put in buildings, and yet he did not forbid it, and his only reason was that with the converter working warm some of the insulation might smoke a little bit and some one might cry fire, pull the fire alarm and call out the department. I believe we have lost one converter only in the hundreds we have got up here in town. It was mechanically defective.

DR. MASON: The man wanted a cradle simply because he had a daughter and that daughter might some time have a baby.

I would like to ask Mr. Smith in regard to one point touching switchboards. I understood him distinctly to say that he had used none but stone or metal. Am I right?

Mr. Smith: No, I did not say anything about the material of the switch. That is a question that I would like a little light on myself. We have been accustomed for some years to regard slate as the best material, but within a short time I have had an annoying accident happen from the use of slates, owing to the presence of mineral in the slate itself. I came across a statement in one of the journals that marble should not be used on account of the presence in that of so many pieces of mineral; that slate was the only good material. But I find that the pure white Italian marble can be had in blocks without any mineral in it whatever, and it seems to me as though that would be the only substance that could be thoroughly depended on. But that will, of course, be quite expensive. For that reason I somewhat favor putting all switches and cut-outs and work of that kind on marble or porcelain bases, but making the switchboard itself of wood and allowing no wires to be clamped directly to it, keeping everything off the switchboard two or three inches. An air space of three or four inches will protect your board pretty thoroughly against fire. With a board of that kind, if there was danger of catching fire, I would not hesitate to turn the hose on it.

Dr. Mason: Did I understand Mr. Smith to say that on a switchboard he would use none but an absolute water-proof insulation?

Mr. Smith: No, sir; I said nothing about that. I want an insulation that will not carry fire. Underwriters' has been very good for switchboards for that reason, and it has been reasonably safe for men, because the switchboard is generally in the driest part of the station. The underwriters' wire, however, is not by any means what we ought to have. It is purely a makeshift. But we do want for switchboards some wire which will not carry flame, which cannot be set on fire either by the heat of the copper in it or by flames striking it from the outside.

DR. MASON: There seems to be no substance which can be put on for the insulation—nothing that is practical—that is absolutely water-proof, excepting rubber or gutta percha. I think that can be taken as a settled thing.

MR. SMITH: For that reason I say I do not lay so much stress on the wire being absolutely water-proof on the switchboard, because a wire is generally thoroughly dry. What I want is a wire that will not carry flame, and which will be reasonably safe for the men working about the switchboard. On a live switchboard you have got to go in among the wires and to take some risks. We want to make those risks as small as we can.

DR. MASON: Do you not see an advantage in having an absolutely water-proof wire?

MR. SMITH: It would be an advantage, but I do not see an advantage of having a water-proof wire offset by the danger of fire.

DR. MASON: Any gentleman who has trouble with his switchboard, if he has an absolutely water-proof line and has any sort of a cotton covering over it and will soak it with a solution of tungstate of soda, he cannot burn it if he tried.

MR. DE CAMP: Mr. Smith's paper is, in my judgment, the ideal paper for this organization—a paper just what we are organized to receive and discuss. It is a paper at great length, covering a great deal of detail in which knowledge gained by practical experience is very limited at this time. It will lead to a very lengthy discussion to do it justice. There are a great many of the members of this Association who will be better able, better qualified to discuss it after having read it carefully, taking it up point by point, than they are at the present time. For myself I am not able to discuss the paper and probably never will be, but I would like to hear it very thoroughly discussed. Therefore, I would make this suggestion, and if the suggestion meets with favor I will resolve it into a motion. I would suggest that Mr. Smith's paper be put on the list for discussion at our next meeting in the shape of unfinished business if you choose. In the interval every one at all interested in it will have read it. Mr. Smith will have had time to reconsider it, perhaps, and prepare himself to answer some pretty hard if not very foolish questions. If that suggestion meets with favor I would move that it be laid over as unfinished business for discussion at our next meeting.

DR. MASON: I rise to second the motion and also to say that if Mr. Smith had not so excellently discussed it I should like to have brought up myself here the matter of the construction in this city, which has commended itself to every man who knows anything about construction, who is here at this Convention, which has been the subject of remark. Not that there has been any want of appreciation of the elaborate station and the arrangement in the station. But this matter of construction here is noteworthy as tending to answer the question, Shall wires go underground or not? There is nothing unsightly. It is almost a thing of beauty. I second the motion of Mr. De Camp.

JUDGE ARMSTRONG: I agree very heartily with that, and may I make this suggestion—that very interesting papers are given here; there is more or less attempt to have them discussed appropriately, but with such a paper as has been presented here by Mr. Smith, the discussion and the interest we all have would be immeasurably benefited and increased if we could have six months in which to look over and ask questions concerning it. Of course, I am not an expert at all, but to me this paper seems the most interesting that we have had at the Convention, and practically, I presume, it will do more for the electric lighting interest than even knowing about the proper way to measure the candle power of incandescent lamps, for instance, or some other such matter. They should be interesting to those engaged in that scientific part of the business. One thing has been referred to that I would like to mention here. I am president of an electric lighting company. It is not at all unbecoming for me to say that I do not know anything about electricity. Of course, the president of a company is not expected to know anything about that. I do know, however, a good deal about the expenditures of money and what stockholders think of the large amount of expense. I want to say, if there are any of your stockholders here, Mr. President, that I believe your company has come nearer filling the mission of a public enterprise, to which I referred last night, than any enterprise of which I know. That magnificent station that you have there, building for the future, preparing the supply for the public demands that may be made upon you, making duplications and arrangements by which, almost under any contingency, you can meet the public demand, is something which, though it has cost your stockholders a great deal of money, as it must have cost them, they can well feel satisfied with having expended the money for. The enterprise, the bravery, the patriotism, if you please, that will prompt a company to make such an investment as you have made there, is, I take it, a thing of which they may well be proud, even although they do not get dividends for some time yet. It is a proper business investment with which they should be well satisfied and of which we, as representatives of electric companies, who have our money invested in this enterprise, should be proud as placing on a solid, substantial, commercial standing, the business of electric lighting. When you will find that a company will stand $300,000 to make a start, putting in such engines as have been put in there and such shafting as has been put in that station and making such large preparations for a great business, it is a stronger argument than anything else as to what electric lighting is and will be in the near future.

As to your pole-line, I must say that I thought we had, measurably, a very good line, that is, on a small scale. But who will object to the line of electric light wires running through the streets of Providence as we have seen them? It is quite an ornamental thing really. There can be no objection to that. It is a costly thing, I have not a doubt, from the looks of it. I have not a doubt that the Narragansett Company paid a good deal of money to have the line run. It is a mighty fine thing and I desire to compliment you, feeling very well satisfied myself as representing a company and to compliment the electric light fraternity throughout the United States that here at this place where we have met, we find an ideal station, a station of which I am proud, and of which your stockholders may well be proud. (Applause.)

Mr. Francisco: I have listened with a good deal of attention to Mr. Smith's paper, not only on account of his able argument, but also on account of the practical part of it. That is the kind of paper that central station men want. This paper alone ought to induce every central station man in the United States to join this Association and come in here and get these practical points. The very faults that he has pointed out here—I know of several stations that have been laboring and spending hundreds and thousands of dollars to overcome when they could have got the points right here from Mr. Smith and not had any of the outlay or trouble.

In regard to this station here, when I was engaged in getting information in regard to municipal ownerships for the paper which I read at Cape May, I spent a good deal of time in looking up central stations. I traveled from Maine to Colorado, from Washington Territory to the Gulf of Mexico, and examined almost every station in that circuit, and, of course, went through the whole rigmarole. Without wishing to compliment our President too much, I must say that not one single station have I visited that I thought compared with the Narragansett station of Providence, taking all the different points together. In the first place, it is substantial. It is based upon a right principle of extension, that is, of extending the business indefinitely almost, and is also based upon the principle, I think, of economy, which is a very important thing in our business, and I have examined the lines, as has been remarked here and has been stated and I fully concur in what has been said in regard to the pole lines, so that I will not occupy time in enumerating those.

I also wish to congratulate our President on the success of his reception last night. (Applause.) We have had quite a number of receptions. I have attended receptions in different parts of the country, and I will not except the reception of the President of the United States. I consider that the one last night was ahead of anything I have ever seen, even the reception of the President of the United States.

Mr. Seely: I am a very little fellow and represent some small companies, but I rise to oppose Mr. De Camp's motion, first, because we have put our money on several smaller stacks of different colors (laughter), and I think we might pump Mr. Smith while we have him here. I would like to ask Mr. Smith these questions if I am in order.

Mr. De Camp: I would call for the question. I have no objection, if the meeting does not want it laid over, to proceed with the discussion, but, if it is to be laid over I do not want it discussed now. Another thing, Mr. Chairman, if you will allow me—

The President: Does Mr. Seely yield the floor?

Mr. Seely: I yield the floor to Mr. De Camp.

Mr. De Camp: The session is being prolonged very properly, but there are several other papers to be read. I understand that we have resolved to finish up our business to-day. This is a question which involves the whole session—we would have too little time to devote to it. Justice cannot be done to it. I am sure that the author of the paper would like to have it thoroughly discussed. You are indebted to him for the care with which he presented that paper. You want to do it justice in the discussion of it. You cannot do it justice in the short time you have at your disposal. Therefore, I call for the question.

Dr. Mason: I want to suggest this thing—that the Executive Committee request Mr. Law to prepare himself to open this discussion. Mr. Law has made some preparations and has a very valuable point that we would want to consider in the next six months. I would suggest that Mr. Law put his remarks in writing, or that we give him a few moments to bring the subject before us. These points, I believe, have arisen, out of his eminently practical and singularly interesting experience in the past year.

Mr. De Camp: I think there is a point in that, but at the same time Mr. Law's remarks will be subject to the same criticisms as the original paper itself. Now that takes time, and it is only for that reason that I have made the suggestion. If he will put it in writing I think that would be a very appropriate thing to do. If I know Mr. Law, I think very likely he would prefer to do that.

MR. SEELY: It may be a long time off, and in the meantime we may be going on doing this bad construction and putting these converters on the exterior of buildings and spending our money, and so forth, and as I have the floor I will say a few words, anyhow. A converter on the exterior of a building means a pole in some cities. They won't even allow you to put them on a frame building in a great many cities. They are putting them in cellars, against buildings and on the top branches of trees. I see some insurance men here and I would like to have their views on the subject. Why don't they allow us to place converters on the exterior of buildings?

MR. BARTON: I am very sorry, indeed, Mr. Chairman, that you recognized my friend Mr. Francisco before you recognized me, because he took, in a measure, the wind out of my sails. To my mind, in discussing the title of this interesting talk of Mr. Smith's, we are losing sight of the fact that it is one of the most interesting talks that we have ever had. We have had the pleasure of listening to Mr. Smith on the question of alternating systems at a great many conventions, and one would think he had worn the subject entirely out. I desire to say this much, however, that I listened with a great deal of interest to the first paper that he read. I have listened with more intense interest to every one he has since read, and this one is the best of all. I desire to express myself in the superlative degree and I think I voice the opinion of almost everybody present. It is a paper that contains meat, bone and sinew. It is a paper that the president, director, manager, superintendent and every subordinate employé of any central station should take and wear in his hat. It contains the carefully studied out experience of a man whose experience I do not think is excelled by that of any one in the country in the working of the alternating business. It covers the general field as well, and we could not discuss it and do it justice if we were to stay here all day. I do not think it needs any great discussion. It is written and has been delivered to us in such a plain, straightforward, understandable way that anybody can understand it almost without discussion. There are certain points of difference in regard to whether a converter should be outside or inside and as to the construction of switchboards and insulation, and all those things about which there will always be differences; but when it comes right down to considering the paper as a whole, as dealing with the minute details of the whole system, I think, if the paper is taken and carefully studied out by everybody who has an interest in the alternating system, it will give them a great deal of commercial good. I simply desire to make this statement more as a matter of privilege. I consider it one of the most interesting papers that has ever been presented to this Convention.

The question was called for.

DR. MASON: We understand it will be with the suggestion that Mr. Law be requested to put his remarks in writing to be put with the paper.

THE PRESIDENT: The sense of Mr. De Camp's motion, as the Chair understands it, is that the formal discussion of the paper of Mr. Smith, of Philadelphia, be laid over until the next meeting of the Association, Mr. Law to put in writing the remarks which he otherwise would offer in opening the discussion of this paper.

JUDGE ARMSTRONG: That includes putting it in pamphlet form so we can have it outside the proceedings.

THE PRESIDENT: Outside the proceedings?

DR. MASON: Why is that necessary? Every member will have a copy of the proceedings.

MR. ARMSTRONG: Yes, but we want that separately.

THE PRESIDENT: The amendment, I understand, is accepted.

The motion was carried.

THE PRESIDENT: Mr. Barton, will you state for the benefit of the Association, in a general way, what constitutes the objection of the underwriters to placing the converters inside buildings. It seems to be a matter that emanates from your province. We would like to know definitely and specifically.

MR. BARTON: You, yourself, covered the whole situation in a very brief and plain way. There is no particular objection. The objection that we took in the beginning in New England was, perhaps, primarily because it was a new thing; because it was, perhaps, considered on the safe side to have converters on the outside, while we never realized or thought there was any danger from fire in putting converters on the inside of a building. Still they were new. The construction of converters to-day is very much superior to what it was when it began—the question of insulation—and, I think, the time has come, perhaps, when it will be better, for many reasons, to put converters into good, suitable locations inside buildings than outside. But, I believe, it was a wise decision that arose in the beginning to exclude them from the inside of buildings, and I do not think that to-day there is any serious objection. But, still, I do think if they go inside of buildings that the same objection holds, to a certain degree—that of the possible smoking of the converter and the alarm of fire, perhaps, that might ensue from such an accident, and they should be placed in some location, somewhere near the bottom story or in the basement or cellar, where the atmosphere is suitable for it. I think that is really the proper location for it.

THE PRESIDENT: It was really a precautionary measure at the time the order was given to exclude them. But practical working for a number of years has shown there is really no objection to it at all. We do not have any smoking or heating up. It does not occur.

MR. BARTON: It does not occur. It was thought that it might occur, but it has not occurred. The objection is not so serious as you thought it was. I believe in putting them in the way Mr. Smith suggests, with a porcelain knob behind them, merely as a matter of ventilation.

MR. SEELY: I desire to state, Mr. President and gentlemen of the Convention, that the only trouble or accident from converters placed inside, that I have been able to hear from, is in one or two instances, where the converter was placed in the interior of the buildings, and there was leakage from the primary to the secondary and thence to the shell. In getting up and placing your hand against the converter you receive a severe shock. After building a box around that——

MR. FRANCISCO: I rise to a point of order. This question has been dismissed by a vote.

MR. SEELY: I ask the ruling of the Chair.

THE PRESIDENT: The Chair will have to rule that it is a little out of order.

MR. SMITH: Now, Mr. President, even after that ruling, I would like to make an addition to my paper. I do not know whether the subject has been closed or whether I can do so with the consent of the Chairman of the meeting.

MR. DE CAMP: I have no objection to your putting it in your paper.

Mr. Smith: I will promise not to talk any more than one minute and a half, and in that time wipe out the necessity for a great deal of discussion.

The President: I think we will close the discussion, unless the Convention wishes to grant Mr. Smith a minute and a half. I think you can proceed, Mr. Smith.

Mr. Smith: I wish to say that if there is any city in this country that has done more to damage the electric light business than any other, it has been the city of New York. I also wish to say that about one year ago, in walking up Broadway, I saw a converter of well-known make placed on the exterior of a building by being laid upon its back on one of those side window sills, in a building where the basement was used as a business office. The wires from the secondary of the converter ran down through a rubber tube without any tape, right down underneath and into the basement. The primaries were connected to the main line with wire that looked to be of a very inferior weather-proof line wire tape, and the tape over those joints was hanging from that in strips. Right by this converter was an iron stairway reaching to the first floor of the main building, and any one could stand on that stoop and put his hand on that converter. After we had all this question in New York, and this fearful cutting of the wires, and so forth, I naturally supposed that that would be one of the first converters to be swept away. Not two months ago I walked up Broadway and that converter was there still. No rules you can make as to putting converters inside or outside of buildings will make them safe when such criminal recklessness as that is indulged in.

Mr. Seely: I will ask the Convention if I may respond to the remark of Mr. Smith? I desire to state that I am not connected with any electric light company in New York. I also desire to state that in New York they have a Board of Fire Underwriters, inspectors, a city electrician and all of the luxury pertaining to first-class construction. Mr. Smith has described it. That is why I insist on these gentlemen formulating rules, so that we shall know exactly what to do and how it shall be done.

Mr. Law subsequently dictated the following discussion: Mr. President: I have listened with great pleasure to the reading of Mr. Smith's paper, and heartily agree with him in all that he has said, more especially in what he says in regard to the good construction of lines, of which we see a most excellent example here in Providence, for I certainly never saw a better construction than what is shown by the Narragansett Company. It undoubtedly has cost them a large amount of money, and may, perhaps, appear like an unnecessary expense, but in time they will reap the reward for such construction. For the past year I have been connected with a large Western company, where a striking example of poor construction is shown. Where it will cost them a large amount of money to put it in anything like a safe position, and the worst part of it is that the directors are not willing to spend the money that is necessary to put these lines in good shape. But the time is coming when the sad state of their lines will force them underground, or a limited time in which to put them in good condition.

One of the principal faults of bad service, especially in the use of alternate currents, is in poor line construction. Another mistake made in running lines where other wires are used than those of alternating currents, is in placing the alternating wire on the top; this should be kept down low, as there is not the danger to dynamos from the crossing of wires, as a cross on a direct current wire does not, as a rule, mean any damage to the apparatus. But in the case of a cross on alternating wires it means a burned-out armature, unless insulations are especially good, and the circuit is fused very close to its maximum load. I find this a very important point to look after. Examine all fuses carefully every day, and never have the circuits fused to more than 10 amperes above record of the daily run.

Mr. Smith speaks of the necessity of carefully fusing primaries of the converters. When I took hold of this Western company I found that in a large proportion of their converters the primary fuses had been taken out, and No. 14 copper wire substituted. In the case of a burn-out in the converter, it will, under these conditions, mean a burned-out armature. If you have any number of dynamos the ampere load of each circuit should be kept within the smallest unit of your machines. This means the ability to make rapid changes in times of trouble without danger of overloading them.

A great mistake is made in putting the switchboard too close to the wall; especially when the fuses are put on the back of the board, and the board should be so arranged that a man can get out at any time, as it is sometimes rather a hot place, and not a good location to get penned up in. Each and every circuit should be provided with both volt and ammeters, as Mr. Smith has stated. And, in addition to this, it is a good thing to arrange a many point switch, that you may at will connect a standard Cardew or other voltmeter to any circuit; in fact, this could be done several times a day, as the voltmeters in constant use are liable to get out of calibration. This is especially useful if you are placed in the position in which I was, where your directors refused to get the copper, which is necessary to even up the loss on lines, and you get into the position where you have 30 per cent. loss on one line and only two per cent. on another. In this case the extra voltmeter is absolutely required.

Great care should be taken that the exciter wires, when they lead from bus-bars, are amply large, that there may be no loss between exciter and alternator, or you may require such a high voltage in your exciter circuit that it may be dangerous to your dynamos. Where such wires are carried under the floor, and the floor on the ground, do not allow the use of an ordinary wire covered with soft rubber tubing, as it is very dangerous from the fact that the oil which gets on them softens the rubber. A better plan is to make a small conduit or trough and thoroughly bed and cover the wires in plaster of paris; this is a good insulator and will prevent the entrance of oil or allowing fire to follow the wire.

Another important point in the construction of lines is where the primary loops are led off from the main feeder; as a rule, these wires are half spliced on to the main feeder and carried directly to the converter. This should always be done at the pole and such wires so arranged that it is impossible for a cross to occur where the primary wire crosses that of the main feeder; this I find to be a common fault, and in several instances, to my own knowledge, has resulted in a No. 6 wire burning entirely through a No. 0 wire and dropping the live wire in the street. Great care should be taken that this wire is carefully fastened at the pole in such a position that it will be impossible for a cross to occur.

THE PRESIDENT: The next paper is on "Mutual Insurance of Accounts," by Mr. Frederick A. C. Perrine.

MUTUAL INSURANCE OF ACCOUNTS.

MR. PERRINE: I must explain the incompleteness, if not the inaccuracy, of this paper by the fact that the idea was conceived not very long ago and has been worked up as thoroughly as I could do it without very extensive reading, which would have taken time. As you all remember, the Baring Brothers, of London, tried to float the Argentine certificates, and, failing in doing that, they came back so heavily on the Bank of England that the reserve of gold diminished and a panic was only averted by a loan of gold from the other governments. In this country the American certificates owned abroad were sent here in such quantities that, in the face of the shaken confidence of our people, we did not have the ready money to buy them up. At the same time the reserves of gold were withdrawn from the bank. Every one seemed to want to get in his own money, and confidence was more and more shaken. Following soon after that the Clearing House of New York issued certificates which merely amounted to saying that we believed that we are safe, and those certificates in the event of actual failure of the Clearing House would have amounted to nothing, but the banks were going to support each other. Shortly after that, Edward Atkinson proposed, at a meeting of the Boot and Shoe Club in Boston, that this principle should be applied to general life; that the money should not be essentially a gold value; that is, the currency of the country should not be gold, but the currency of the country should be Clearing House certificates payable on demand in gold, and the gold in the country should be kept in the bank reserved until such a time as it would be demanded and paid out. In that way, he says, the currency will be ample for the volume of business in the country and the gold reserved, all being in the bank, amounting to $600,000,000, would be ample for carrying on the business. At present we are attempting to carry on the business with $600,000,000 scattered all over; and thinking of his paper I conceived the idea which I wished to present.

Mr. Perrine then read the following paper:

The recent financial crisis has been happily passed in a manner never before attempted or imagined in the history of business and banking. At any moment one of our sensation-loving newspapers, willing to handle fire, might have precipitated the whole country into financial ruin, by persistently teaching fear and liquidation, but taking, as they did, an optimistic view, they did not check the new force in banking—mutual support.

It may be objected to the use of the term, new force, that "mutual support" is the very underlying principle of banking as it has always been practiced, but its application in approaching times of panic is almost new enough to be called a discovery. Mutual confidence in ordinary times is but the belief that any one, when individually called upon, can at any time meet his current obligations, but the principle applied by the bankers of Europe and by our New York Clearing House, is essentially the belief in the solvency of the country, or the world as a whole. Two forces tended to bring about this happy result, one acting here and the other abroad.

In Europe the Barings were not the only bankers heavily involved in South American securities. They, indeed, were the heaviest holders of Argentines, and had taken the initiative in attempting to float them, but, failing in this, the load became too heavy for their individual shoulders, and their fellows were ready enough to give them aid, which would also protect the smaller holders, in which number is included all except one or two of the great bankers.

Six months or more ago, the possibility of a crisis had been foreseen by our bankers, some of whom are intimately connected with South American affairs. By them it was known where lay the greatest financial dangers, and that these dangers concerned us only indirectly, through our speculative markets, rather than through the ordinary channels of business. When the crash came, and the worst was averted by the ready loan of gold abroad, our clearing house, feeling that a lack of confidence was the one dangerous element, ventured upon the experiment of the issue of a new form of currency, namely, the clearing house certificates.

Now, that the air is clearing and we look about us, we find among the most sensitive lines of business the industry of electric lighting. Very few of the companies are thoroughly on their feet as regards ready cash, being but young, and spending their earnings in necessary extensions; almost none are individual concerns, the majority being stock companies, and, as a consequence, feeling immediately the waves of the market. Many, noticeably the electric railroads, were in the midst of initiative constructions, and just about to float their bonds; but we can proudly say that nearly all were, and are, looked upon as successful business ventures, safe enough while confidence lasts.

These considerations have lead to the thought that, without looking to outside bankers or business men, the electrical business should form an association of confidence, capable of rendering them independent of the market, if not even a stay to it, in future crisis. It is thus that we see an association of confidence used by the bankers of the New York Clearing House, and following immediately upon their action, the timely speech of Edward Atkinson before the Boot and Shoe Club, of Boston, proposing its continuation as a general principle, and its extension to the needs of everyday life, in a money issued by the clearing houses, based upon the stability of the business men of the country, and backed by a reserve in coin, only to be called upon in time of greatest need. In the course of his speech, to show how little the risk, he cites the fact that, in his extended experience of business, the losses through bad debts have not amounted to one-half of one per cent. of its value; this low average, I believe, has hitherto been much too high, applied to the electric light and railroad industries.

If, in a view of these facts, the electrical companies would form a mutual association for the purpose of insuring their accounts, the effect would be that of increased capital in the business, relieving their creditors of much of their anxiety, and rendering stable the stocks and bonds of the associated concerns. The risk of an account is not greater than that of anything else for which insurance is granted; a man's life, or loss by fire, for instance, while resembling rather the latter than the former, is a calamity which no man expects, and one to be guarded against by the most strenuous means. The loss, stated above, of one-half of one per cent., as incident to general business, includes not only the losses due to bad management and dishonesty, but also the failures occasioned by these very times of weak faith, against which this plan is directed. These being eliminated, the business losses of an electrical company could be reduced to a minimum, and dividing these losses among the many, would make them a burden to none, while conferring upon all the benefit of a practically increased capital of a credit money.

In detail, the plan should be to form, among the electrical companies, a mutual assurance society, each company pledging individually its entire capital for the assurance of all accounts outstanding against any member, for which benefit a charge should be made covering expenses through administration or losses, proportionate to either the capital involved or services rendered.

The assurance of the account could be affected in one of three methods, either of which would require elaboration and further study. First, the association might issue a series of promissory notes payable on demand, by means of which accounts could be settled, and which could be sold to various companies whose notes could be taken in exchange; this would involve a possibly expensive administration, and considerable ready capital, besides being probably liable to a tax imposed by the government on a circulating medium.

Secondly, the association might, without injury, insure all accounts, and be called upon only to adjust in case of failure. This would allow the greatest opportunity for dishonesty, and make it extremely difficult for the association to ascertain at any time its liabilities, except by a complicated system of book-keeping, involving the rigid inspection of the books of the insurance companies.

The third, which appeals to one as being the simplest plan, is that the association appear as an indorser on notes, or an insurer for accounts, when called upon to do so by any member, thus taking the position of a trust company. In the case of any one of the insured companies becoming involved, action should be taken by the association, dependent upon the contingent circumstances; in the case of temporary embarrassment, the notes should be paid to the holders on maturity, and the company carried by the association till such a time as it could discharge its obligations. Were mismanagement apparent, the association should have the power to enforce a more economical or honest administration; or if, finally, the business was found to be necessarily unprofitable, the creditors should be paid in full and the company be closed out for the benefit of the association. No surrender of administration is contemplated here before such a time as the account could be shown to be in actual danger.

The insurance of an account may seem on first consideration to be rather a startling innovation in business methods, but I believe it to be based upon a firmer and more rational foundation than the insurance against loss either by fire or accident. Both of the latter are based on a system of probabilities in which the insured expects his policy to be greater than his premiums, and the success of the company proves it not to be true in the long run; the mutual insurance of an account, on the other hand, depends on the belief that all the accounts will be, in the main, stable, and that internal faith will induce a greater faith from the outside.

The objection that it is a scheme of the weak companies to be supported by the strong, and that they who would offer the greatest stability would not enter it, is answered in two ways: In the first place, as has already been said, the companies involved in the electrical business are in almost no cases individual concerns, and, as stock companies, are subject to extraordinary effects of bad and expensive management and fluctuations of the market; secondly, they are none of them so solid and stable as to be entirely removed from fear of depression, or need of funds for extension. Again, the very principle involved is that, as a whole, there are no weak companies in the business, if only times of depression be avoided.

To the objection that an unlimited liability company would be avoided by all, the same answers would be offered, with the addition of pointing to the Guarantee and Accident Lloyds, of New York, and Lloyds, of England, as stable examples of the application of the principle to ordinary insurance.

The initial subscription of the small amount of a few thousand dollars by each insurer, would be the capital needed, its only use being to meet imperative accounts, while the administration would be of the simplest, requiring a minimum staff of efficient men whose services would be called upon to adjust irregularities and issue insurance.

This scheme is offered to the electrical fraternity, believing that by it the best interests of both the electric light and railway companies and the supply houses will be preserved, and that through it the electrical interests will not be a menace, but become a source of stability to the finances of the country.

DISCUSSION.

MR. DE CAMP: I was first struck by the title of the paper, which I could not understand, and I was very forcibly struck and astounded by the suggestions made. They were entirely new. I had not the honor of knowing the author of them, but I feel myself safe in assuming that he never had to manipulate the finances of an electric light station. It seems to me that it did not apply directly to the stations. He speaks of history when he quotes the late lamentable experience of the Barings. The Argentine Confederation was trying to do what the parent companies have been trying to do for the last two years—to bite off more than they could chew. Therefore, I look upon anything of that kind with a suspicion. The fact is, that the central station lighting companies need no protection if their foundation is on business principles. I never knew a central station company to fail to meet its obligation, except from want, first, of a sufficient amount of capital to do its business. I do not take it to be the province of this Association or any other association to insure against any insufficiency of capital in any business. The second cause of failure of the lighting companies has been their income not being sufficient to meet their expenses. That I do not think any association of gentlemen want to put themselves in a position to insure. Referring back to the late troubles—they grew, in short, out of overtrading in various directions. If there is any need of mutual insurance of accounts among the people who have been looking to the central stations for the payments of their bills, of course, that means the companies that have been furnishing them with apparatus, and they have been doing just exactly what the South American States have been doing—they have been overtrading. They have been organizing companies where they were not needed. They have been promising profits which could not be realized. That has gone farther. The parent companies, as we call them, or the manufacturing companies, are obliged to be creditors of somebody else. The competition among the manufacturers of material used by the manufacturing company has led them to go beyond the bounds of good judgment in extending their credits. In other words, the time came when there was a settling day and settlements have not been had certainly in a satisfactory way. There is no mode of insurance under Heaven can protect any community against such business methods. (Applause.)

Mr. Perrine: I think I might answer Mr. De Camp. He evidently thinks that I am a seller of materials. I am with the Roebling Company. I have been an electric light man ever since I have been in business, and that is one thing that brought this to my mind, as I said, with a good deal of pride that our business last year with the electric light companies amounted to close on a million dollars, and out of that we lost one account, amounting to $1,200, which was not a case of bad judgment, but a case of a man running away with the funds of the company. And that shows to my mind very clearly that the electric light companies are on a firm basis and that they are not companies that, as a rule, you are risking much in trusting. But I have seen cases—more when I was with an electric light company than now—when some of the best business of the company had to be lost; when it was necessary to allow ruinous competition to come into a town because the stockholders said, we know you are paying us good dividends and we know you are making extensions on what you are earning, but we won't give you any more money to make any more extensions, whereas the business was well worth borrowing the money on to make the extension, and it was practically a mutual bank where you have not six per cent. for your money, which is fixed by law, or seven per cent., or eight per cent., as it happens to be, but the actual cost of furnishing what is wanted, which is very much below. It is hard times when call loans are about two per cent. and that is more nearly the actual cost of lending money. I did not bring this up because we have lost accounts. In fact, I brought it up because we had not lost accounts, and as I may say in our business last year we lost about $1,200, so our losses have certainly been away below one-half of one per cent.

Dr. Mason: I think Mr. De Camp will agree with me that as it is now quite late and we have very important matter—that matter of data, and perhaps another matter that the President has on his mind, to come before us—I think you will desire to have me make the motion that the discussion on this paper now close.

The motion was carried.

THE PRESIDENT: The next item on the calendar is the report of the Committee on Data, A. J. De Camp, Chairman.

REPORT OF THE COMMITTEE ON DATA.

The report of the committee will be presented in two sections.

Part First will treat of the subject of "The Dangers of Electricity," growing out of the action taken at the Twelfth Convention on the paper presented on this subject by President Henry Morton, of the Stevens' Institute of Technology.

Part Second will treat of the subject of "Standards of Economy in the Generation of Power," growing out of the action taken at the Twelfth Convention on the paper presented on this subject by Mr. H. M. Swetland, editor of *Power*, New York.

Mr. Swetland has kindly consented to assist this committee by preparing this section of the report, and to present it in person.

Conforming to the instructions given to it by the Twelfth Convention, two circulars of inquiry were prepared and sent out of the office of the Association to all Central Station Companies in the United States, for the purpose of collecting the statistics desired. These circulars will be printed in the appendix of the volume of Proceedings for this Convention.

THE DANGERS OF ELECTRICITY.

Replies to the inquiries regarding personal injuries to workmen employed by central station companies, have been received from 213 companies, Of this number, 45 companies failed to state the number of workmen employed, but report no accidents ; 168 companies employing 1,233 men, report seven accidents. This report covers the year 1890. It shows that in doing 369,900 days work, but seven injuries occurred. None of the injuries were fatal.

FIRES CAUSED BY ELECTRICITY.

In the matter of fire losses, no data has been collected. I am desirous, however, to lay before the Association an extract from a report made recently by William McDevitt, Chief Inspector of the City of Philadelphia. It is as follows :

Philadelphia Fire Underwriters' Association.
Electrical Department.

"There are over 5,000 buildings in Philadelphia wherein the electric currents are used for light and power purposes. Of this number 287 buildings (seven of which are dwellings) have their own apparatus, the latter varying in size from a 20 light to one of 4,000 lights. The number of lights furnished by these private plants aggregate 80,258 incandescent and 3,325 arc lights. One retail store contains 482 arc lights.

"There are 15 public stations distributing electric currents to all sections of the city, furnishing thousands of lights and power to dwellings, churches and other classes of buildings. The number of lights supplied by these respective stations vary from the very small station, furnishing 2,000, to the Edison, which furnishes over 40,000 incandescent lights, and current for a large number of motors. The electric motors in use are of a capacity ranging from one-eighth to 30 horse-power (being used to a great extent as a substitute for laborious hand or foot power in dwellings and small workshops), and are being rapidly introduced as a more ready motor in place of steam and hydraulic power in propelling machinery.

"All of the different systems of electric lighting invented are or have been given opportunity to operate their respective apparatus in our city, and, wherever consistent with safety, approvals were given for use in insured buildings. In innumerable instances, where no insurance was held on buildings, when electric lighting was introduced, contractors were required to install the work in accordance with the Underwriters' requirements and subject to the approval of the latter's inspection.

"No insurance loss occurred in any building in our city during the past year from fire where the cause could be in any way attributed to electric wires.

"The education of the workmen in the new factor, and the steady improvements made in materials and devices in electric appliances have materially lessened the danger in its introduction; but a little knowledge of the inherent danger in the use and handling of electric light appliances should be had with consumers or users."

INJURIES TO FIREMEN.

In the matter of injuries to firemen from electric currents and fires caused by the same, in returns to the United States Census Office from Chiefs of Fire Departments, the following statements are made:

Returns from Chiefs of Fire Departments, showing number of fires and injuries to firemen caused by electric currents compared with other similar data. For the year 1890.

Total number of towns reporting	367
Total number of regularly employed force	16,143
Total number of enrolled volunteer force	35,510
Total number of alarms calling out whole or part of force	30,862

Total number of fires caused by electric currents.	363
Total number of injuries received while on duty.	1,303
Total number of injuries received while on duty at fires caused by electric currents	26
Total number of injuries caused by electric currents	25
Total number of fatal injuries	55
Total number of fatal injuries caused by electric currents	1
Total number of deaths from natural causes	338
Total number of towns in which firemen are supplied printed rules for the prevention of injuries	1
Total number of towns having an electric fire alarm system	195

MR. DE CAMP: Since this report has been written it occurred to me that in the case of Philadelphia, which has no accidents to report, because there were no accidents of a nature that would come into a report of this kind, they had no relation to the business. We had an epidemic of people falling off poles, and I did not treat it any more than I would the case of a workman going home and falling off a street car. So those were not included, and I take it, from the reports made to us, that they did not look at them as things incident to the business. Consequently, that brings it down to this meagre point.

I would say, further, that if the managers of stations will take the trouble to acknowledge the receipt of these blanks and answer them as far as they can, some of the blanks look very formidable and probably contain inquiries that it is hard to answer in an exact form, but if they are answered in any form, the committee will be very much aided in its work and the committee itself will probably be able to work that out in an intelligent shape to go on record.

So much for the first part of the report. I now have the pleasure of introducing to you Mr. Swetland, who will furnish the report in regard to the statistics which he has gathered.

Mr. Swetland then read the following:

REPORT OF THE COMMITTEE ON DATA.

Part Second.

ON COMPARISON OF ECONOMY IN THE GENERATION OF POWER.

The object of this work has been previously set forth in a very plain and comprehensive manner, but it may be briefly alluded to here, not only to emphasize its importance, but to enlist the earnest co-operation of the members of this Association. The committee have undertaken to record the actual cost in tons of coal of a definite amount of horse power actually delivered; *i. e.*, work actually performed, represented by amount of electric current actually delivered, recording the results obtained from all ordinary types of equipment in use for the generation of power; the idea being to show not only the difference between the results obtained from the more modern and complete installations of those less favored in equipment, but to record the varying results obtained from each special type of equipment under different management, making the comparison of coal with coal, boiler with boiler, engine with engine, type with type, and appliance with appliance.

These records will enable the manager of an electric plant having an ordinary equipment to compare his results with those plants operated under exactly similar conditions. To this end, the following inquiry circular was sent to all central stations in the United States:

COMPARISONS OF ECONOMY IN THE GENERATION OF POWER.

Extract from the Proceedings of the Twelfth Convention.

"*Resolved*, That the subject of Mr. Swetland's paper, 'Standards of Economy in the Generation of Power,' be referred to the Committee on Data, with the suggestion that it report at the next Convention on the points touched upon in the said paper."

NATIONAL ELECTRIC LIGHT ASSOCIATION,
18 Cortlandt Street, New York City.

To Companies, Firms and Persons Operating Electric Lighting and Power Stations.

GENTLEMEN: This Association desires to benefit your Company:

First, By securing data as a basis for making "Comparisons of Economy in the Generation of Power."

Second, By furnishing such a report, based on the data obtained, as will enable each manager to determine if his results are as favorable as the best results obtained by others operating under similar circumstances. If not, to see in what details his deficiency occurs.

Through the kind courtesy of Mr. H. M. Swetland, Editor of *Power-Steam*, these blanks will be sent to a large number of managers of steam power plants operated for various purposes. His report on the returns received will be submitted in connection with the report of the Committee on Data, on the returns received from electric light and power stations. This will determine the best engineering practice and where it may be found.

In order to have these reports for the Thirteenth Convention, to be held at Providence, R. I., February 17, 18 and 19, it is necessary that the report for your company be filled out and returned at once.

Respectfully,

NATIONAL ELECTRIC LIGHT ASSOCIATION.

By ALLEN R. FOOTE,

Secretary and Treasurer.

REPORT TO THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

1. Name of company?
2. Full address?
3. If a lighting station give lamps in use:
    Number incandescent?
    Number full arc?
    Number half arc?
4. If not a lighting station, give character of business?

FUEL.

5. What kind and grade of fuel do you use, giving what percentage of ash?

FIRING.

6. Is your firing done by hand or stoker?
7. What kind of grates do you use?
8. What is the amount of draft in inches of water?
9. Do you use forced or natural draft?
10. Do you use the automatic damper regulator?

FEED-WATER.

11. Temperature?
12. Is the water free from scale-forming substances?
13. If not, what means do you use to prevent the formation of scale?
14. Do you use a feed-water heater or an economizer?
15. Is your feed-water handled by steam, power pump and injector, or pressure from city mains?

BOILERS.

16. What is the style of your boilers, horizontal, upright, tubular or water tube boiler, or any other special design?
17. Do you use any special setting?
18. What per cent. of entrained water do you get with the steam used?
19. How many pounds of water do you evaporate per pound of coal?

ENGINES.

20. What type of engines do you use, throttle or automatic governor?
21. If automatic, do you use Corliss or shaft governor, or some special type?

22. Are you running compound, triple or quadruple expansion?
23. Do you run condensing or non-condensing?
24. If compound, is the style cross compound or tandem, and are receivers used between the cylinders?
25. Does your engine run full load, or what part of full load are you developing?
26. What speed do you run?
    Revolutions per minute?
    Piston feet per minute?
27. How many pounds of steam (water) do you use per indicated horse power per hour?

TRANSMISSION.

28. Do you transmit power to dynamos direct, or do you use countershafts?

RESULTS.

29. What is the nominal capacity of your boiler plant?
30. What is the nominal capacity of your engine?
31. How much coal do you use in 24 hours?
32. How many hours do you run out of the 24?
33. What is your average indicated horse power during this run?
34. What is the average break or net horse power delivered by the engine?
35. What is the average electric horse power per hour?
36. How many pounds of coal per indicated horse power per hour?
37. How much coal per electric horse power per hour?

EXTRACTS FROM PROCEEDINGS OF TWELFTH CONVENTION.

Paper on Standards of Economy in the Generation of Power.

By H. M. Swetland, Editor of "Power-Steam."

"In the electric lighting business, where so much is new, and development is so constant and rapid, it is essential that there should be established some authentic form of comparison of operations, with the view of reaching the greatest economy in the shortest possible space of time."—*Swetland.*

"The subject of economy in general has received the attention of our best thoughts, but it has been directed to the operations of the complete system, and too often details of definite expense are overlooked by the superintendent whose imperative duty is the running of the plant, not its most economical methods."—*Swetland.*

"The material for the data in furnishing standards of economy should naturally be the practical results of actual operations compiled in tables from the results obtained by different managers. To what end? They will interest and benefit all desirous of investing in electric light and power enterprises, which are becoming such an attractive feature in the financial world. They will be useful to prevent the establishment of unnecessary and injurious competition frequently induced by statements of so-called facts and figures showing an utterly false and unattainable economy."—*Swetland.*

"To the superintendent of the station, more than any other person, these tables will be of paramount importance. They will enable him at a glance to learn what others are actually accomplishing under certain named conditions, and readily to institute comparisons with his own records. By their use he will not only gain enlightenment on many points, but be stimulated to the highest possible degree of efficiency and economy. He will also thus be furnished with unimpeachable authority to offer a doubting stockholder or too exacting president who, while perhaps not being initiated in the details of practical workings, is always glad to be reassured by accurate information."—*Swetland.*

"My plea is for the most minute and detailed system of tabulation as the means of reaching the best results. It is by the comparison of coal with coal, boiler with boiler, engine with engine, type with type, appliance with appliance, that these results may be obtained."—*Swetland.*

"Not only should there be no objections on the part of the companies, their managers or superintendents, to giving information that is reliable in character, accurate in detail and comprehensive in scope, but there ought to be the most cheerful acquiescence."—*Swetland.*

"We are organized for purposes of free interchange of thought and experience, with a view to mutual advancement and benefit. In these tables each one is liable to discover information upon some important point which should be of great value to him.

Naturally, the broad ground of justice, fairness and liberality of feeling is expected to be our starting point."—*Swetland.*

DISCUSSION.

"We want a report on the actual cost of producing power in central station practice in this country, giving actual data of operation, that is, the nature of fuel, the nature of steam equipment and the nature of engine equipment."—*Garratt.*

As will be seen the questions asked for definite data: First, as to equipment; and second, for information regarding the time and amount of fuel required to generate a definite amount of horse power.

The call has been responded to liberally by the different companies, something over 400 returns having been received up to date, from which the foundation of this work has been fairly started, and the compilation of data has been commenced.

Arrangements have also been made to obtain data relative to the economic generation of power in other branches of manufacturing. Results obtained in the engine room of the cotton mill, the rolling mill, and various other industries, together with their special equipment, will be recorded for the benefit of comparison with the results obtained from similar equipment in electric lighting. Five hundred circulars to leading manufacturers have brought out a ready response, and we must confess these returns show an elaboration of detail and a conciseness of calculation, which prove that the question of economy in the generation of power is not a new one to the manufacturers.

The returns from the central stations are the best evidence that could be offered as an argument in favor of this work, for, while many of the returns are complete, proving that a faithful record of the cost of the required power is at the disposal of the manager, a large number of them report no tests made or no records kept, and in several instances the whole quota of questions was answered by the very expressive and comprehensive statement "never mind the cost of power, we are paying dividends." Those sending complete reports often accompanied the returns with a letter of inquiry as to what others were doing with a similar equipment, expressing marked interest in the work of the Committee, and asking for a copy of the Report when completed, and we predict that future reports from a "no data but dividend paying" element of these returns will, in the near future, withdraw their statement regarding dividends and report themselves as doing less business or out of business, having failed to meet successfully the competition of the manager who knows what power costs and sells electric current at a fair margin of profit on that basis.

In a very few instances only were all the questions in the circular answered. The evaporation of water per pound of coal was stated in only 21 reports. In a less number of instances was the percentage of entrained water stated, and the question relative to the number of pounds of steam used per horse power was often considered altogether too intricate and far reaching.

Now, while answers to these questions are imperative to successfully compare appliance with appliance—all those reports which gave work performed and fuel actually consumed were useful and formed a basis of a good beginning. The main idea of the inquiry circular was, however, often lost sight of or ignored, and the question of the amount of coal used, or its reciprocal question relative to the work performed, left unanswered, while nearly all the others were answered in full. However, as has been stated, sufficient has been received to furnish the foundation of this work, and more than enough to satisfy the most sceptical of the absolute necessity of the records.

If the business of the electric lighting is to be successfully conducted, a fair basis of first cost of power must be made the basis of charge for the service rendered, and if one horse power can be generated for one hour by burning one and one-half pounds of coal the consumer of electric light will not long be satisfied to pay a profit to that electric plant whose management is satisfied to burn ten pounds of fuel for this same horse power.

The reports received in many instances show evident haste in preparation, but as received they convey a record of expenditure for fuel varying to the extreme mentioned above. A large number of plants are reported as burning from eight to ten pounds of coal per horse power per hour; very few, even with the modern equipment of higher expansion and condensing engines were able to show a record below three pounds of coal per horse power, while other equipments of the same class report an equivalent duty with one-half of the expenditure of fuel.

As the inquiry circulars have only been in the hands of the different companies a few days, a large percentage of them have not reached the hands of the Committee. It has been impossible in this short space of time to issue a complete report in time for this Convention. If the work can be continued until the next Convention, the Committee feel confident of being able to place in the hands of the members of this Association a report which will be of special value.

The following is a tabulated summary of the reports received:

EXHIBIT A.

No.	Fuel.	Feed Water.	Purity.	Boiler.	Evap.	Engines.	Lbs. Steam per H. P.	Speed.	Load.	Average H. P.	Hours per Day.	Lights Delivered.		Fuel per Day.	Coal per hour per H.P.
												Arc.	Incan.		
A 1	Soft	190	Pure	Hor. Tub.	7	Aut. Non-Cond.	35	240	⅔	66	12	25	650	4,000	5
A 2	"	200	B. C.	"	......	"	....	200	Medium	38	5½	....	325	1,000	4.8
A 3	"	212	"	"	......	"	32	80-250	Full	150	15	Full 70 Half 60	2,600	14,000	4
A 4	"	150	"	"	......	"	....	212	"	30	6½	....	350	6,000	30
A 5	Slack	196	SuperHeated Steam	"	......	"	....	300	50%	60	12	2	800	4,000	6½
A 6	Soft	200	....	"	......	"	....	250	75%	85	15	22	2,200	9,000	7
A 7	Slack	205	Pure	"	......	"	....	325	Full	96	24	62	1,300	7,500	3½
A 8	Soft & Coke	Heater	B. C.	"	......	"	....	300	⅔	40	14	....	200		
C 9	Pea	200	"	"	9	CorlissNon-Cnd	29	86	85%	202	6	....	903	4,000	3.3
A10	Hard	Heater	"	"	......	Aut. Non-Cond.	....	300	Full	110	7	120	60	3,000	3.6
A11	Pea	180	Pure	"	......	"	....	350	"	......	16	....	1,100	3,800	5
A12	Soft	190	Soda	"	8	"	25	220	75%	60	6	Half 49	600	2,240	3½
13	Slack	Heater	Coal Oil	"	......	Triple Expan.	......	365	Full	60	4½	22	350	10,800	10
A14	Soft	200	Pure	"	......	Aut. Non-Cond.	....	247	"	135	24	35	8,200	16,000	5
A15	Pea	210	"	"	......	"	....	334	....	6,855	24	Full 190 Hlf. 190	5,653	20,565	3
16	Coal & Wood	Heater	"	"	......	Comp. Cond.	....	280	60%	......	14	....	800	3,000	
A17	....	200	B. C.	"	......	Aut. Non-Cond.	....	......	....	......	24	130	5,600	14,000	
A18	Pea	90	SlippryElm	"	......	"	....	282	Full	60	8	50	500	2,500	6
19	Soft	130	Blowing	"	......	Aut. Cond.	110	270	"	70	16	30	1,200	3,000	4
A20	"	Heater	Pure	"	......	Aut. Non-Cond.	....	310	"	......	12	Half 25	900	6,000	
21	....	120	B. C.	"	......	Aut. Cond.	....	174	"	140	18½	120	700	6,000	2½
A22	Soft	225	"	"	......	Aut. Non-Cond.	....	300	¾	45	10	6	750	1,640	4
A23	"	Heater	Pure	"	......	"	....	260	Full	......	7	90	500	3,500	
24	"	160	"	"	......	Aut Cond.	....	134	"	100	13	Half 72	2,200	3,500	3
A25	"	Heater	Some Scale	"	......	Aut. Non-Cond.	80	150	....	50	6	Half 60	400	1,400	4½
A26	Pea	198	Soda Ash	"	......	"	....	270	Full	30	5	....	450	1,000	6½
A27	Soft & Slack	209	Pure	"	8½	"	....	334	....	34	12	....	2,000	3,000	4½
A28	Soft & Coke	Heater	"	"	......	"	....	285	Full	......	8	100	85	1,000	
A29	Soft	"	Kerosene	"	......	"	....	152	¾	......	7	....	800	2,700	
A30	Dust	Inject'r	B. C.	"	......	Aut.	....	150	Full	......	13	40	500	8,000	
A31	Slack	Escape Steam	....	"	......	"	....	200	"	......	12	29	250	6,000	
A32	"	210	B. C.	"	5	"	....	265	⅔	......	15	73	700	13,000	8
33	"	Cold	Oil	"	......	"	....	275	Full	50	14	....	650	8,000	12
A34	Coal	Heater	B. C.	"	......	Aut. Non-Cond.	....	250	"	55	6	46	......	....	3.91
A35	Slack	180	Pure	"	......	"	....	220	¾	......	13	80	650	8,000	

EXHIBIT A.—Continued.

No.	Fuel.	Feed Water.	Purity.	Boiler.	Evap.	Engines.	Lbs. Steam per H. P.	Speed.	Load.	Average H. P.	Hours per Day.	Lights Delivered.		Fuel per Day.	Coal per hour per H. P.
												Arc.	Incan.		
A36	Nut	Heater	Pure	Hor. Tub.	......	Aut. Non-Cond	....	285	¾	......	13	75	....	5,000	
A37	....	"	Soda	"	......	Aut.	....	280	Full	50	7	15	200	9,000	5
A38	....	"	Coal Oil	"	......	Aut. Non-Cond.	....	290	....	70	13½	....	1,250	4,000	4
A39	R. M. Coal	100	Pure	"	......	"	....	100	¾	100	13	....	1,500	3,000	3
B40	Pea	Heater	"	"	......	Aut. Cond.	....	300	Full	......	16	....	750	2,600	
41	Cumb. and Brick	185	Soda Ash	"	9	"	....	290	¾	......	24	300	2,600	32,000	2.10
42	....	210	Pure	"	9½	"	....	128	Full	200	13	121	1,521	5,700	2.10
43	Slack	200	"	"	......	Aut.	....	275	½	50	7½	....	500	3,000	8
A44	Pea & Coke	Almost Boiling	"	"	......	Aut. Non-Cond.	....	375	26 H. P.	26	8	30	....	1,000	5
45	Wood	170	"	"	......	Aut. Cond.	....	350	Full	......	7	....	500	150 feet.	
A46	Many Kinds	165	Scale No Remedy	"	......	Atlas	....	210	⅛	18	6½	15	59		
A47	Ill. Lump	212	B. C.	"	8	Aut. Non-Cond.	....	......	....	......	24	100	7,000		
A48	Wood	212	Pure	"	......	"	....	265							
49	Soft Slack	164	"	"	8.42	Aut. Cond.	17	372	⅜	......	24	214	1,800		
A50	Wood	200	"	"	......	Aut. Non-Cond.	34	255	Full	40	12	....	1,600	3 Cords	34
A51	Hard Wood	190	"	"	......	"	....	275	70%	80	14½	....	1,400	3¼ "	
52	....	Nearly Boiling	"	"	......	Aut. Cond.	....	325	½	40	14	....	....	3,000	6
A53	Pea	Heater	"	"	......	Aut. Non-Cond.	....	205	....	32	14	....	491	2,100	5
A54	"	210	B. C.	"	......	" "	....	185	Full	......	18	....	900	6,000	
A55	Soft	110	Pure	"	9	" "	....	265	"	......	16	Full 88 Half 44	2,174	12,000	
56	Coal	Boiling	B. C.	"	......	Throttle "	....	320	"	......	13½	22	700	4,000	
A57	Pea	197	Pure	"	7	Aut. Non-Cond.	....	220	"	......	15	Half 210	2,100	15,000	
A58	Soft	212	"	"	......	Aut.	....	200	....	125	13	112	1,300	4,500	3
A59	"	212	"	"	......	Aut. Non-Cond.	....	302	Full	......	9	Half 93	36	1,750	
A60	Slack	150	"	"	......	"	....	225	"	......	7	24	140	2,500	
A61	Nut Slack	180	B. C.	"	......	"	....	245	¾	165	14	74	1,600	10,000	4⅛
A62	Slack	160	Kerosene	"	......	"	....	102	Full	65	12	40	750	6,000	5½
A63	"	180	Scale No Remedy	"	5	"	35	240	"	95	16	65	3,315	14,869	10
A64	Pocahontas	200	Kerosene	"	......	"	....	250	⅗	30	13½	Full 20 Half 18	125	3,300	5
65	Slack	Coil	Pure	"	......	Ball Comp.	....	296	½	......	6½	....	400	15,000	
66	Soft	150	"	"	6	Aut. Cond.	30	206	Full	90	12	43	1,000	4,200	6
67	"	190	B. C.	"	......	"	....	275	⅘	......	6	31	265	3,000	

EXHIBIT A.—Continued.

No.	Fuel.	Feed Water.	Purity.	Boiler.	Evap.	Engines.	Lbs. Steam per H. P.	Speed.	Load.	Average H. P.	Hours per Day.	Lights Delivered.		Fuel per Day.	Coal per hour per H. P.
												Arc.	Incan.		
68	Coke	112	Heater	Hor. Tub.	......	Aut.	....	260	Full	......	9	Half 89	....	2,250	
A69	Slack	150	B. C.	"	10	Aut. Non-Cond.	....	275	"	......	12	....	1,200	8,000	
A70	Ind. Block	216	"	"	10	"	....	260	¾	95	10	Full 40 Half 60	....	4,000	5
A71	....	185	"	"	......	"	....	240	⅞	38	10½	....	300	1,600	4½
A72	Pea	205	"	"	......	"	....	285	Full	......	14⅓	Full 187 Hlf. 113	1,350	14,200	
A73	"	204	Pure	"	......	"	....	320	⅘	......	13	....	1,050	3,500	
A74	Soft	212	B. C.	"	......	"	....	287	½	......	12	40	300	6,000	7½
A75	Coal	208	"	"	......	Aut. Non-Cond.	....	225	Full	100	6½	120	....	3,000	5
76	Slack	212	Pure	"	......	Throttle "	....	350	"	35	7½	....	500	2,500	4.8
A77	Culm.	212	"	Upright	......	Aut.	....	385	"	40	20	....	450	4,000	5
A78	Nut	190	"	Hor. Tub.	......	Aut. Non-Cond.	....	250	"	50	7	51	....	2,140	6
79	Slack	50	"	"	5	Aut. Cond.	90	270	⅔	90	8	67	500	6,000	6
A80	Soft and Screenings	200	"	Loco.	......	Aut. Non-Cond.	....	180	⅘	......	6	Half 195	....	4,000	
A81	Soft Slack	189	Pet.	Hor. Tub.	8½	"	....	270	⅘	200	12	175	3,065	10,000	7½
A82	Soft	Heater	Pure	"	......	"	....	280	Full	60	7	Half 15	500	1,500	6
83	Wood	112	"	"	......	Corliss Cond.	....	80	....	40	12	....	3,000	4,000	5
A84	"	212	"	"	......	Ant. Non-Cond.	....	130	Full	125	9	34	640		
A85	Slack Nut Pea	210	Potatoes	"	......	"	....	143	⅗	......	6	....	450	1,750	
A86	Slack	80	Coal Oil	Shell	......	"	....	300	⅓	......	6	....	120	20,000	2.75
87	Indiana	135	B C.	Hor. Tub.	7½	Aut. Cond.	17	136	Full	750	24	Full1500 Hlf.280	1,300	70,000	3.8
A88	Soft	200	"	"	......	Aut.Con.&Non.	....	132	"	......	24	460	3,000	29,000	
A89	Slack	175	Clean	"	......	Aut. Non-Cond.	....	275	"	68	14	....	1,200	6,000	6½
A90	Coal	205	B. C.	"	......	"	30	266	½	43	5	23	200	1,500	7
A91	Pea	210	"	"	9	"	27	135	Full	750	16	600	800	30,000	3
92	Domestic	91⅞	Pure	"	5.9	Aut. Cond.	17⅓	85	7/10	470	8	....	....	....	3½
93	Pea	200	Kerosene	"	......	"	....	235	Full	130	24	70	2,000	14,000	5
A94	Soft	150	Black Oil	"	10.9	Aut. Non-Cond.	....	300	"	......	7	....	1,000	4,000	
A95	"	200	Filter	"	......	"	60	180	¾	60	11	40	450	1,750	3½
A96	Pea	190	Pure	"	12	"	50	215	Full	350	16	330	1,300	25,000	4
97	Soft	203	B. C.	"	......	Aut. Cond.	....	225	Vary	......	24	Full 133 Half 51	5,000	40,000	
A98	"	Heater	Pure	"	......	Aut. Non-Cond.	....	320	Full	......	14	40	900	6,500	
A99	Wood	"	....	"	......	Aut.	....	120	....	150	2	93	750		

NON-ELECTRIC COMPANIES.

No.	Fuel.	Feed Water.	Purity.	Boiler.	Evap.	Engines.	Lbs. Steam per H. P.	Speed.	Load.	Average H. P.	Hours Per Day.	Lights Delivered.		Fuel Per Day.	Coal Per H. P. per hour
												Arc.	Incan.		
1	Soft	210	Pure	Hor. Tub.	Varies	Aut. Cond.	....	100	Vary	......	10				
2	Pea Dust	170	Clearing	"	......	Thr'tleNon-Con	....	63	Full	......	10	....	....	10,000	
3	Pea Dust Slack	212	Pure	"	6.41	Corliss	3.6	72	½	170	10	....	....	15,680	
4	Pea	200	Purifier	Water Tube	......	Harris Corliss	....	70	Full	.....	24	....	44	12,000	
5	Hard Soft	199	Pure	Hor. Tub.	9.14	Aut. Part Cond.	26.69	54	⅞	700	10	....	....	19,800	2.92
6	Soft Gleanings	150	"	"	......	Aut. Cond.	....	125	⅞	35	15	....	....	1,000	2½
7	Pea Dust	157	"	"	8¾	"	14½	55½	Full	1140	10	....	....	30,000	1.9
8	Coal Shavings	212	B. C.	"	8½	Corliss Cond.	20	68	½	220	10	12			
9	Nut Slack	200	Scale No Remedy	Uprig't Tub	13	Corliss Aut.	....	50	⅜	......	10	....	....	10,500	2⅝

MR. FRANCISCO: I move that the report be accepted and the Committee continued.

The motion was carried.

THE PRESIDENT: The last item on the calendar for this morning is the report of the Committee on the World's Columbian Fair, myself as chairman, I will report that I have notified Director-General Davis, of Chicago, of the appointment of this Committee, and of its willingness to co-operate with him in a way to secure the success of the exhibits. I received a reply that my invitation had been received and placed on file, and at the proper time would be answered by the proper person.

JUDGE ARMSTRONG: I move that this report be received and the Committee continued.

The motion was carried.

JUDGE ARMSTRONG: I move that we now adjourn until four o'clock.

THE PRESIDENT: I will say to you, gentlemen, that the first thing on the calendar for the business of the afternoon will be the executive session, at which time you will probably select your officers for the ensuing year. It will be well for all to be present.

MR. DE CAMP: Do I understand that we are going to wind up to-day?

THE PRESIDENT: I understand from the Secretary that we are going to conclude the business of the Convention to-day.

The Convention then adjourned until 4 P. M.

AFTERNOON SESSION.

RECOMMENDATIONS BY EXECUTIVE COMMITTEE.

THE PRESIDENT: This being an Executive Session, it is desired that all who are not active members and all who have not as yet presented their credentials to the Executive Committee will either do so or retire.

At a meeting of the Executive Committee held last Monday it was unanimously decided to recommend to the Convention when it gathered in Executive Session that it resolve it into a Committee of the Whole and nominate in proper order the officers for the ensuing year.

They further recommended that in the make up of the Executive Committee some thought should be taken in regard to selecting men who can and will attend the meetings and transact business. It is with considerable satisfaction that I say to you that at every called meeting during the past year there has been present a majority of the members of the Executive Committee who have served you. (Applause.) You who were present in Kansas City know that I was not particularly desirous of acting in the position which I have filled during the past year, but I did determine and made a solemn covenant with myself that I would be present, let come what may, at the meeting of the Executive Committee; and as I accepted the responsibility from your hands I tried to discharge it faithfully. (Applause.) It should not be considered a mere empty honor to be named on the Executive Committee. Therefore, select your men wherever you will, but have it understood that they will attend to the meetings.

The third recommendation is that while some of the members believe their should be one convention in the year, after a full discussion, the majority of the Executive Committee believe that for the present, at least for this year, there should be two conventions held. Business of such rapid development, evolution going on on every side, the tremendous advances which we have made in ten years, and particularly during the time covered by the thirteen conventions that we have held, show very clearly that once a year is much too seldom to come together to discuss these subjects, compare notes, and look into the new questions that arise. They, therefore, recommend that you hold, as hitherto, a midsummer convention. The Executive Committee also suggests, in the same connection, that in selecting the place the most important considerations are that you name if possible some point where some new and important work is being carried out.

Those three recommendations are before you. Gentlemen, I am ready for your further action.

JUDGE ARMSTRONG: In accordance with the recommendations of the Executive Committee, I move that the Convention now resolve into a Committee of the Whole, retaining for the officers of such Committee the present officers of the Convention.

The motion was carried.

ELECTION OF OFFICERS AND PLACE OF MEETING.

MR. SEELY: I believe the Convention is now again in open session?

THE PRESIDENT: Yes, sir.

MR. ARMSTRONG: If there is no objection, I ask that by unanimous consent the report of the Committee of the Whole be considered as having been made.

THE PRESIDENT: If there is no objection, it will be so considered.

DR. MASON: I now make a formal motion that the Secretary be instructed to cast the ballot of this Association for the gentlemen named by the Committee of the Whole for the several officers of this Association.

The motion was seconded and carried.

THE SECRETARY: Gentlemen, I have to report that the ballot is as follows:

For President, C. R. Huntley, Buffalo, N. Y.
First Vice-President, James I. Ayer, St. Louis, Mo.
Second Vice-President, M. J. Francisco, Rutland, Vt.

Executive Committee.

CLASS 1.

E. F. Peck, Brooklyn, N. Y.,
John Seely, New York City,
C. R. Faben, Jr., Toledo, O.

CLASS 2.

Albert J. Corriveau, Montreal, Can.,
H. H. Fairbanks, Worcester, Mass.,
A. J. De Camp, Philadelphia, Pa.

CLASS 3.

J. J. Burleigh, Camden, N. J.,
A. M. Robertson, Minneapolis, Minn.,
E. W. Rollins, Denver, Colo.

THE PRESIDENT: I declare that the list of officers read from the ballot by the Secretary are the unanimous choice of this Convention for its officers.

MR. ALEXANDER: I now move that the recommendation of the Committee of the Whole, fixing the place of the next meeting at Montreal, Canada, be adopted.

The motion was seconded and carried.

THE SECRETARY: I suppose the memorandum will be that the meeting be held in Montreal in the month of August, the Executive Committee to arrange the date?

THE PRESIDENT: Yes, sir.

MR. SHAW: I desire to offer a resolution at this time, as follows:

Resolved, That within 30 days of his election the incoming President shall appoint a committee of three active members of the Association, whose duty it shall be to formulate such amendments to the Constitution as may be deemed necessary, and to submit their report at the next semi-annual meeting of the Association; the amendments thus reported to be introduced at the semi-annual meeting and lie over under the rules and be considered at the next annual meeting of this Association.

The Constitution is all right as far as it goes, but I think there can be some remodeling done to it.

The resolution was seconded and adopted.

MR. SEELY: I move that a vote of thanks be tendered to the President of this Association, to the Reception Committee, and to the Committee on Exhibition, for the courteous and masterly manner in which they have entertained this Convention.

The motion was seconded; put to the Convention by Dr. Mason, and carried unanimously, amidst applause.

DR. MASON: Mr. President, I beg to announce that the vote is a unanimous one.

THE PRESIDENT: Gentlemen, I simply propose to thank you. I have no remarks to make. I have tried to make your stay here a pleasant one, and if you have found it worth your time and trouble to come down to our small town to hold your Convention, I trust you have not been disappointed. (Applause.)

MR. FRANCISCO: As the Convention has decided to go to Montreal next August, I hope we shall have a full delegation up there. I know from past experience and personal knowledge that we will have a right royal reception there.

THE PRESIDENT: There was to be some action on the report from the Committee on Incandescent Lamps, and they have made an instructive report. That is the committee of which Dr. Bell was chairman. Will you take some action on that report?

MR. ARMSTRONG: I move that the report be accepted and the committee discharged with thanks.

The motion was seconded and carried.

THE PRESIDENT: The Committee on Legislation have reported. I think it is a standing committee and should be continued.

MR. SHAW: I move that that committee be continued.

The motion was seconded and carried.

THE PRESIDENT: The Committee on Underground Conduits and Conductors.

DR. MASON: I think I made a motion to discharge that committee, and it was carried. I now move that a committee of three on Underground Conduits and Conductors be appointed to report at the next meeting.

The motion was seconded and carried.

Dr. Mason: It may be needless for me to say so, but I request that the usual courtesy to a mover will not be regarded in this case, as, of course, I could not serve on that committee.

THE PRESIDENT: A paper on How Can the National Electric Light Association Best Serve Central Station Interests? I think Mr. C. R. Huntley will give practical exhibition of that during his presidency. (Laughter and applause.)

SERVICE OF THE ASSOCIATION TO CENTRAL STATION COMPANIES, AND THE REPORT OF THE TWELFTH CONVENTION.

MR. HUNTLEY: Mr. President and gentlemen: We have all heard of chestnuts, and I am very glad that there is no bell ringing on this. (Laughter.) Whoever selected me to write this paper made a mistake. My selection has not been productive of any paper whatever. It is not often that I am on my feet at this Convention, but I was there at Cape May and made the remark that the best interests of the Association could be served by making it a business Convention. I still think so. I see my friend De Camp over there is looking a little pleasant at me and I have an idea that he thinks, perhaps, I can preach a good deal better than I can practice. I dare say that I can. I do not think there is a point to be taken up in the matter of meetings. I think that an annual meeting is quite enough for us to have. It has come to me frequently during this Convention and during the other, that our interests can be best served by meeting annually instead of semi-annually, and, I believe, we will have to face that question sooner or later. I won't say that, at this time, it will be the wisest thing for this year—perhaps not. But it is in keeping with all other organizations of the same character as our own, and as we grow older, I believe that once a year will be often enough for us to meet, and that smaller stations would come in and our membership would be increased thereby. While the data that the Association has given us of late are of incalculable value to us, I do not think that we want very much of it. A little of it is all right. The work that Mr. Foote has done for us, in compiling some of the reports, is of especial value. It has served me in many instances, and in the last three or four weeks, pending the contract for lighting in our city, and thereby we are served well. I will not burden you with any more recommendations of this kind, gentlemen, and if I am asked to write another paper I will try to do better than I have this time.

THE PRESIDENT: I would say that Mr. Huntley, who, under the old constitution, from August to January, was chairman of the Executive Committee—myself on January to next autumn—that in his behalf and jointly we offer this volume of our proceedings as the report of the Executive Committee, and I will warrant it will be found to contain as much actual work and individual effort as has ever been put out by any secretary that this Association has had.

MR. HUNTLEY: I want to congratulate the secretary on the able manner in which he has compiled that book. I think that each member of the Association will find that that book is a volume that he will refer to frequently and profitably. If our future volumes can be edited in the manner that that is, we will have on our desk a volume which can be seen and read every day with great profit.

DR. MASON: I would like, Mr. President, if I may, to emphasize what you have just said. I have examined that book with considerable care. I am familiar with the publishing of books. I do not know where a more elegant volume will be found. I do not know where one freer from typographical errors, if I can judge from the examination I made, can be found. It is a book of taste. It is one I would like to preserve on my shelves along with other standard works.

THE PRESIDENT: The secretary has made a request, and I really think that the Convention can afford to grant it, and that is, that it be made an order that the next and future publications of the Society shall be uniform in style and binding and general arrangement with that one.

MR. ARMSTRONG: I make that motion, Mr. President. It is a good suggestion.

The motion was carried.

THE PRESIDENT: The Secretary's report is next in order.

REPORT OF THE SECRETARY.

SECRETARY FOOTE: As your Secretary, I will report on membership:

Active members, names on roll for 1890 were 123. Dropped for non-payment of dues, 19. Total number of active members' dues paid for 1890, 104.

Associate members on the roll for 1890, 166. Dropped for non-payment of dues, 25. Total number who paid dues in 1890, 141. The two classes of membership together make an aggregate of 245, dues paid for 1890.

I wish to explain one point that cannot appear here about dropping of the members for dues. Under the old constitution it frequently occurred that two or three men in one company paid memberships. They took them in their individual name and paid for the memberships. Since the constitution was changed so that the membership stands in the name of the company, where we have the same company we have but one membership. That accounts for some of the dropping of the names. This you will understand is the report for 1890. I suppose some of you wish to know how we stand to-day. As no person was a member of the Association till he paid his dues in 1891, we have received dues, active members, 59, and six who have given their tickets for their checks, making 65 active members' dues paid to date. Associate members, paid, 101, and six tickets, making 107. So that the membership dues paid since the first of January of this year are 172. That is the report as Secretary.

THE PRESIDENT: Next is the report as Treasurer.

REPORT OF THE TREASURER.

TREASURER FOOTE: The report of the Treasurer is as follows:

Balance on hand July 1st, 1890,	$1,233.60	
Active members' dues,	610.00	
Associate members' dues,	540.00	
Advertisements, Proceedings 10th & 11th Conventions,	800.00	
Sale of Publications,	3.00	
Bills Payable,	1,000.00	
Total to be accounted for		$4,186.60

DISBURSEMENTS.

Salary for secretary and treasurer,	$1,088.29
Proceedings 10th and 11th Conventions,	1,319.00
Rent of office,	162.72
Twelfth Convention expenses,	320.72
Traveling expenses,	67.85
Postage and telegrams,	187.89
Sundry expenses,	174.93
Printing and stationery,	215.05
Furniture,	144.15

EXPENSES OF COMMITTEE.

Standardizing potential for street railroad,	21.60	
Memorials,	5.00	
Copper tariff,	110.00	
Legislation,	107.50	
Total disbursements,		$3,920.42
Balance an hand,		266.18
		$4,186.60

This report is certified by the Auditing Committee of the Executive Committee, as follows:

PROVIDENCE, February 19th, 1891.

That the Finance Committee of the National Electric Light Association do hereby certify that they have examined the books and vouchers of the said Association and find the same to correspond with the hereto attached report.

(*Signed*) FINANCE COMMITTEE,
JOHN A. SEELY,
M. J. FRANCISCO.

MR. SEELY: Mr. Secretary, the statement previously made was July 1st to Jan. 1st. Isn't it July 1st to January 31st?

THE SECRETARY: No, sir; January 1st.

MR. SEELY: I would also like to ask the amount of money that has been collected since January 1st up to our meeting here February 19?

THE SECRETARY: I wish to add a little to the report I made. I did not embody it in the report because I did not know whether the Convention wanted it to appear in the record. That report shows bills payable $1,000. At the same time there are bills that have not been audited or paid, created in the month of December for printing; sundry printing bills, $202.85, and for the printing of the Prospectus and Review of the Twelfth Convention proceedings, $134.00. That would make the total debt of the Association at that time $1,336.85. Deducting from that the cash on hand the net debt of the Association on the first day of January this year was $1,070.67.

Now, I will answer Mr. Seely's inquiry. The cash received for dues since the first of January has enabled me to pay the loan of $1,000. I have paid all the current expenses except the printing bills that I have just reported. I have paid myself for the month of February, so I am little ahead, and we now have on hand $2,548.93.

MR. SEELY: Does that include the collections from the advertisements that have come in?

THE SECRETARY: I have omitted all reference to the Twelfth Convention, and for this reason; the bill for printing 1,000 volumes of the book you have seen is just a little under $1,300. My own estimate was, when I started that book, that it would cost $1,200. The printer's estimate was $1,000. I have his bill, which includes printing a thousand volumes, the wrapping and mailing of them, and everything pertaining to the issue of the book, and it is just a little under $1,300; say $1,300 in round numbers. I have planned to put in the book sixteen pages of advertising, for which I expect to get $100 a page. As a part of the consideration for the advertising I propose to advertisers that, when the book is completed, I will take the sixteen pages of advertisements, the title page of the book and the table of contents, and make it into a pamphlet in the same style as the prospectus I spoke about, and mail that pamphlet to every company in the United States. That will cost in the neighborhood of $200, and adding that to the cost of the proceedings, it will run the cost of the issue up to about $1,500. If I place the sixteen pages of advertising at $100 a page it will, as you might say, evenly pay the bills so that the issue of the volume will cost the Association practically nothing. I now have half of that advertising under contract, and, undoubtedly, could have had it all, but I had so many other things to attend to lately I could not give sufficient time to this.

MR. SEELY: My object in asking for these points to be brought out was to show the financial condition of the Association. A year ago, when our President was elected, it was reported that this Association would break up in six months, and at that time the executive board went into session and we discovered that there was $1,200 turned over to this executive board with a great flourish. Shortly afterwards we discovered that the Association was deeply in debt, and we had to borrow money to pay the debt. We, as members of the executive board, thought that it did not become the dignity of the gentlemen to belong to a body that could not pay its debts. Consequently, when the creditors pressed us, the members of the executive board put their hands in their pockets and paid the debts. I believe the Association is to-day in a more flourishing condition than it has been in since its organization. We could pay all the debts to-day up to the present time, collecting what is due us, and have a surplus of $2,800.

MR. ALEXANDER: I was going to make a motion that the reports of the secretary and treasurer be filed.

THE PRESIDENT: If that is your pleasure gentlemen —I hear no objection—such action will be taken.

I will interrupt the proceedings just for a minute. As a last act of courtesy to me, for when we meet again I shall cease to be your President, Mr. Edward Weston is here from Newark, N. J., and he wants to talk for a few minutes, and I will ask you to remain in your seats and not go away, and the Executive Committee earnestly recommend that this Association elect Mr. Weston, for the splendid original work that he has done in inventions—particularly of late in central station instruments—elect him as an honorary member, and that I be permitted now to invite him into the meeting.

JUDGE ARMSTRONG: I move that the recommendation of the President be adopted.

The motion was carried, and Mr. Weston was escorted to a seat upon the platform.

THE PRESIDENT: Gentlemen of the Convention, it gives me great pleasure to present one of the four names that stood high in the annals of the American inventors, one of the very first to enter the field of electricity. Yesterday we had with us, Thomson; to-day, Weston. The other two, Brush and Edison, have honored us either by their presence or by letters that show conclusively that they were interested in our proceedings, but were prevented from coming here by circumstances beyond their control. There is no word that I could use that would introduce him to you more fully and completely than simply to call the name of the gentleman, Mr. Edward Weston, of Newark, New Jersey. (Applause.)

ELECTRIC MEASURING INSTRUMENTS.

MR. WESTON: The President has requested me to make a few remarks, gentlemen, in regard to electric measuring instruments and their methods of use and care. A few years ago such a thing would have seemed almost impossible. The growth of the industry has been so enormous and the money invested so great that it gives me indeed great pleasure to see that the gentlemen who are engaged actively in this business every day realize the value and necessity of accurate work in the mechanical departments and in the electrical departments.

Like almost every other industry there is an experimental state, which is probably the most trying stage, when disappointment after disappointment occurs, first with the apparatus, and later on from a lack of knowledge of its limitations. As that disappears, people become better and more fully acquainted with the need of stricter and closer attention to all the details, in order to assure complete commercial success. In 1881 to 1882 a proposition to place a voltmeter of excellence or an ammeter of excellence on every plant or in connection with every dynamo, as was suggested here to-day by Mr. Smith, would have been met, I think, very largely by ridicule. That was not the fault of the users as much as it was, probably, of the people who were engaged in pushing forward the commercial end of the business. The users could not be expected to understand that matter or appreciate that if they did not use such appliances it, in the end, made considerable loss.

I was greatly pleased to-day with the paper of Mr. Smith. It embodied so many excellent suggestions in regard to the care of plants, the exact means of finding out where difficulties arise, of locating them instantly and removing them quickly. The necessity of continuous hard service has been fully recognized. Mr. Smith dealt very fully with the details of the arrangement that he planned to secure those desired ends. He dealt very fully, also, with the methods of switchboard construction, certainly a very much needed reform. Almost every serious fire that has occurred in an electric lighting station has owned its origin and done most of its mischief through the agency of the switchboard. I have had occasion to examine quite a number of the results of such fires and I have almost always traced it back to their switchboard, where there was an amount of inflammable material collected, which was bound to give rise to some serious trouble. That is nearly wiped out. Wooden constructions are rapidly disappearing. Dangerous insulating materials, likely to carry fire from one section of a building to another, are being given up. The question of insulation is of less importance inside the station than the question of safety from fire. Compared with the early stages of the art it was indeed gratifying to me to find that these things had gradually become recognized as a necessity and not only so recognized, but urged upon the attention of a body of intelligent men such as we have had here to-day.

In regard to instruments I would say this—that almost every instrument has its peculiarity. To speak of them generally you will find that all of them have defects, and all of them must have their merits. They must all be used properly or any one of them must be used under certain conditions in order to yield certain and accurate results. The voltmeter of the Cardew type, which is supposed to be a very permanent form of voltmeter for use with alternating or direct currents, is so extremely sensitive to changes in temperature from external sources as to make quite a perceptible error, and one which would in the end cause a station considerable loss. If any would like to satisfy themselves about that let them place such an instrument in circuit near a window through which the sun is shining, shield it from the sun's rays, turn the current on observing the reading. Let the sun's rays fall on the tube and notice the change. I think most of you will be considerably surprised to find that the percentage of change is very large under those conditions. The Cardew instrument properly used will yield excellent results. It should not, of course, if accurate readings are desired, be placed in a vertical position. The index moves too much, and I believe you all fully realize the fact that a volt or two volts additional on an incandescent lamp enormously shortens its lifetime, besides adding largely to your coal bill.

In direct current instruments it will be supposed by many persons that because many contain no permanent magnet that their readings are not affected by their proximity to a dynamo. Do not believe it. It is not so. It is a very easy matter to ascertain how much their readings are affected under different conditions, but you will find that they are very seriously affected, and in general no instrument that is being used for the purpose of making an accurate determination should be placed near any disturbing force, either conductors carrying powerful currents or other magnetic fields. That should be strictly avoided. The Cardew is less affected in that respect than some others, but it is not entirely free from that difficulty either. Those instruments that are least affected are instruments of the zero type. That is to say, where you balance a known electromotive force against the unknown electromotive force by means of a rheostat—the potentiometer type. Those are less liable to be affected than any of the so-called direct reading instruments. But they are also affected—their sensibility is reduced. In making readings they should never be placed very near dynamos.

Permanent magnet types of instruments, which have certain very desirable qualities for general use in direct current measurements, should never be taken very close to dynamos. If the magnets are properly made and the magnetic construction is good you may trust permanent magnet instruments implicitly for years, supposing they are used with due care.. The most careful examination has revealed the fact that after three years continuous use the change has amounted to less than one-tenth of one per cent. Now, how is that secured and how is it maintained? It is secured in the first place by very careful selection of the steel and very careful artificial etching and also in the design of the instrument. Those three things come into play there. After they leave the instrument maker's hands they sometimes get pretty badly abused. People are not very apt to think how much labor has been spent making those instruments. They should not be used roughly by any means. They should be carried with extreme care and not very much jarred, because the jarring, while it does not affect the magnet at all, jarring and jolting that they get striking car seats and such things, jumping them down on tables, is likely to damage the pivots or jewels which carry the moving parts and so introduce the element of friction. The element of friction is a very serious thing in a very large number of instruments. In some the error will amount to three or four per cent. In others it is much less.

In voltmeters there is another source of error which should be looked after, particularly in some forms of instruments, very carefully. Voltmeters whose coils are wound with copper, unless they have compensators, or some device for compensating for the change in the temperature of the copper, are not reliable instruments to use for station work. It is commonly known, of course, that the co-efficient of error of temperature, as it is commonly called, is very large for copper. It amounts to about one per cent. for every five degrees Fahrenheit. Therefore, a change of 20 degrees introduces an error in such instruments of about four per cent.; a larger change, of course, introduces an error correspondingly greater. German silver does that to a less degree, of course. But even there there are serious difficulties to be met in getting an instrument which, at the same time that the temperature co-efficient is low, will not heat too much by the passage of the current. So that no instrument should be sent out as a standard voltmeter, or as a voltmeter to check other voltmeters, without an absolute statement of its temperature error and some means for providing for its ascertainment. It does not suffice to notice the temperature of the surrounding air, because the temperature of the coils inside of the instrument may be very different from that of the surrounding air, especially after the instrument has been in circuit a short time. The way in which electricity acts is so well understood that all those cases have been pretty well worked out, but in getting accuracy in the instruments there is a great deal more to be done. Some years ago I had the good fortune to discover an alloy in which the temperature co-efficient was practically nothing. We have used that to some extent, not to the extent that I should like to see it used and expect to use it later on. That alloy has given us a great deal of trouble in working. We have had to learn how to work it, and I do not think we fully understand it yet; but when we get that alloy in shape, then the temperature error will be practically eliminated. How near we have approached this elimination, you can judge when I tell you that our ordinary standards—I am speaking of voltmeters, I do not speak of ammeters—the changes are less than one-quarter of one per cent for 35 degrees Fahrenheit.

Regarding the use of instruments it has been very strange to find—of course, this is not in stations, it is generally in isolated plants, but we have found instruments with which you are well acquainted, on the switchboard, nailed up, nails driven through the bases, not even holes bored in. Now, the type of instrument we have put on the market we never intended for switchboard use. It was intended as an absolute standard, to be kept with care for checking other cheaper forms of instruments for general use. As a matter of fact no one meter, strictly speaking, exactly meets the requirements of central station work. The index does not move far enough to enable you to see the minute changes, apparently minute changes, at any reasonable distance from the instrument itself. An instrument for station work should have a very large movement for a single volt, so that a man can see across the room quite readily a change of a single volt. Of course, that cannot be done with the form that we put out. There have been some instruments of that type put on the market. Some had very good qualities; unfortunately some had very bad qualities. There has not been any complete solution, I think, of that problem. The nearest approach to it was two instruments, one made by the United States Company, the other by the Edison Company. Both forms had serious objections. The one did not remain constant; the other did remain, but it was a very delicate instrument, and after being in a station was more or less affected; in fact, considerably affected by external influences. That problem remains to be solved, so to speak, yet, so as to produce a satisfactory volt indicator with a very wide range for a very small change.

Ammeters are, of course, of less consequence. There is not so much loss there as there is when you have the voltage changing. Your lamps do not suffer quite as much. Ammeters are based, of course, upon the same general principles as voltmeters. The forms of them are too numerous, almost, to mention, and too well known to need describing. Some new forms have recently been brought out which I think on test will be found to be very excellent. In a station ammeter you should have at least this one element, that it should not be affected even by the most intense fields, because it has got to be placed very close to the main conductors on the switchboard. It will be of very great importance, much greater importance later on than it is now, when more machines are coupled in multiple arcs, especially when alternating current machines are coupled in multiple arcs. The load that each machine carries should be pretty fairly distributed amongst the various machines. To insure that, good instruments must, of course, be used. Any instrument which is seriously affected by external fields does not exactly meet the requirements of the arc. There is no doubt about that. Furthermore, its index should be prompt, positive, not slow coming to rest, and always moving naturally to the same position from the same current strength and for very little magnetic lag. Most of the ammeters, of course, are based on the action of the coil upon a mass of iron, most commercial forms of ammeters. A great many of them have a very large amount of lag. Some of them I have found to be upwards of 14 or 15 per cent. lag put out with endorsements, and endorsements sometimes of very high authorities, as to their excellence and general accuracy. Tests show them to be just the contrary.

The ammeter question, with permanent magnets, is a much more serious matter to deal with than the voltmeter, and, of course, any permanent magnet would not do at all for alternating current work. A really portable form of alternating current instruments, similar in general character to the portable form of direct current instruments, capable of being read directly, is a very great necessity, and, I think, will be supplied in a very short time. It is practically new and should be an instrument that could be carried around with the same degree of comfort that you carry a direct current instrument.

I need not enlarge very much on this matter of instruments, except to say that if instruments are used with greater care I am satisfied that the members of the Association will get far better results if the help are instructed in regard to the care of the instruments, and it will most assuredly result in profits to the stations.

JUDGE ARMSTRONG: I take great pleasure in moving the recommendation be adopted which was made through the Executive Committee that we elect our guest to honorary membership.

The motion was carried.

MR. WESTON: I am very much obliged indeed, for the honor conferred, and will endeavor in the future, if time permits, to do a little more active work before the Association than I have in the past. Your President called upon me some months ago to know if I would prepare a paper for presentation to the Association. I said I would if I possibly could. I explained to him exactly my situation, and nothing would give me greater pleasure than to have come here to give you a very elaborate paper on electrical instruments in a practical manner, to have illustrated by experiment exactly the behavior of instruments, so that you might see for yourselves what you might expect in their daily use. I am sorry that I could not do it. Business has simply prevented it. For a long time I was steadily engaged on the witness stand in a very troublesome case which has taken four months of my time this year. I explained that to your President; but I am deeply sensible of the honor conferred and I will endeavor to do a little more useful work than I have done before.

THE PRESIDENT: I wish to say that Prof. Weston was just a little bit diffident about speaking on this subject, because he was interested in prosecuting the business, but I am sure that I can say to you gentlemen that the business consideration did not enter into it, but simply years of long faithful study of electricity and its developments was the only consideration at all. We are only to glad to listen to him in his sound practical talk—one of the best we have listened to in the whole Convention, in my estimation.

Mr. Seely: If there is no further business before the Convention, I move you, sir, we now adjourn.

The President: Before putting that motion, I have just a word to say in bidding you an official good-bye. I have to thank you one and all for your uniform courtesy, your earnest and heartiest sympathy and assistance which has been rendered to me all through the year. I feel it, and feel it very keenly. It is very pleasant to have you come and sever my official relation here at my own home, and I am very glad indeed that you have come here and have had an opportunity to inspect what I myself have been trying to accomplish in the way of advancing the electrical industries of the country, in promoting them, putting them on a substantial footing. I do not know there is anything more I wish to say.

Motion to adjourn was then put and carried.

APPENDIX.

INTELLIGENT CARE INSURES SAFETY.

Extract from the proceedings of the Twelfth Convention.

"*Resolved*, That the Committee on Data be requested to examine into and report all accidents happening in electric light stations, and to what cause they may be attributed."

NATIONAL ELECTRIC LIGHT ASSOCIATION,
18 Cortlandt Street, New York City.

To Companies, Firms and Persons
Operating Electric Lighting and Power Stations,
Gentlemen:—

This Association desires to benefit your Company:—

First, By securing data as a basis of satisfying public opinion that accidents occurring to employés engaged in operating electric lighting and power plants, or in the maintenance and care of their lines, are not more frequent, severe, and are seldom different in kind from accidents occurring to employés engaged in operating power plants or power-driven machinery of any kind.

Second, By securing more equitable rates of assurance against losses from claims for damages by employés receiving injuries, by removing public prejudice and furnishing reliable records upon which to calculate risks.

Third, By demonstrating to employés that those who use intelligent care and observe the rules published for their guidance take no unusual risks in following their occupations.

Fourth, By gaining instruction from experience for the purpose of perfecting regulations for the prevention of accidents.

These objects are in the direct line of your interests. The Association trusts that you will unite with others in securing these objects, and, therefore, respectfully requests that you will fill out the within report, and forward the same to this office, and that hereafter you will promptly report as fully and explicitly as possible each accident occurring to your employés during the year 1891:—

If no accidents have occurred to your employés during the year 1890, *a report to that effect will be of the highest value. Do not fail to send it.* Respectfully,

NATIONAL ELECTRIC LIGHT ASSOCIATION,
By ALLEN R. FOOTE,
Secretary and Treasurer.

CONFIDENTIAL REPORT
TO THE
NATIONAL ELECTRIC LIGHT ASSOCIATION.

NOTE.—*In case accidents have occurred, make a separate report for each. Additional copies will be furnished for that purpose.*

1. Name of Employer.

NOTE.—*Give full name of company, firm or person.*

2. Full address of employer.
3. Character of dynamos operated in plant.
4. Continuous currents; highest voltage, highest amperage in use.
5. Alternating currents; highest voltage, highest amperage in use.
6. Total number of employés in station.
7. Total number of accidents in station during 1890.
8. Total number of employés on lines.
9. Total number of accidents on lines during 1890.
10. Report of accident to an employé.

NOTE.—*Give the initials only of the injured person.*

11. What was his regular occupation?
12. Was he engaged in his regular occupation at time of accident?
13. How was he employed when accident occurred?
14. Describe machinery, tools, staging, etc., connected with accident. (If possible, give rough sketch.)
15. Was it sound and in good working order at time of accident?
16. Was he familiar with the work engaged in, or the machinery being operated, at time of accident?

17. Had he worked at a similar occupation prior to this employment?
18. Describe nature of injury.
19. Probable period of disability.
20. Was he obeying instructions when injured?
21. What regulation did he disobey?
22. What regulation, if obeyed, would have prevented the accident?
23. If no rule has been formulated, the observance of which would have prevented the accident, please suggest a rule designed to provide for such contingencies.
24. Date and hour of accident.
25. Place at which accident occurred.
26. Was accident due to want of ordinary care on part of injured person, or the negligence of any other person? If of other person, give duties of that person.
27. Report below in narrative form all the circumstances attending the accident, and give a rough sketch if necessary to enable the cause of the accident to be easily understood.

Extracts from Proceedings of Twelfth Convention.

PAPER ON DANGERS FROM ELECTRICITY.

By President Henry Morton, of Stevens' Institute of Technology.

"Intelligently managed and controlled, the most powerful, and, therefore, in a sense, dangerous agencies become the most efficient protectors and servants of man, and not only aid him in his mission of subduing and utilizing nature, but actually protect him in his work."—*Morton.*

"With the aid of these dangerous agencies man conquers and renders tributary to his comfort and advancement those vast forces which control the entire matter of the universe."—*Morton.*

"So far, it would appear as if no accidents have resulted from the use of electric currents when these rules have been followed, and that most, if not all, the accidents which have occurred would have been prevented had these rules been followed and obeyed."—*Morton.* (Leaflet copy of rules referred to furnished by the National Electric Light Association, 50 cents per 100.)

"Restrictions which might render it (electricity) harmless, certainly would render it relatively useless for the countless purposes in which its efficiency demands its full development."—*Morton.*

DISCUSSION.

"The prejudice existing in the minds of the public is so great, when a suit is brought against a company for an accident to an employé of an electric lighting and power company, he demanding compensation for damages for his injuries—it is utterly impossible to take the case before a jury on account of the prejudice. It is considered that electric lighting companies are carrying on their work regardless of the dangers by which their men are surrounded. This has compelled an increase in the premiums by nearly one hundred per cent. * * * If the result shown by careful reports is what we anticipate it will be, there is no doubt it will be followed up by a reduction of premiums."—*Freethy.*

"If by a careful examination by the officers of this Association, and by a careful report from every company and member of this Association, it can be shown that the accidents in electric light stations are less, proportionately, than in other stations, merely because the men are more careful, dealing as they do with dangerous things, merely because the men are more watchful, having, as they do have, graver responsibilities, then we ought to have the full benefit that other companies get in their insurance. * * * If by giving full and accurate reports of every accident, and of every difficulty that occurs in all our stations, we can convince these Assurance Companies that there is very little danger to employés, we can, in that way, do a great thing and a good thing for our companies."—*Armstrong.*

WILLARD L. CANDEE, } Managers.
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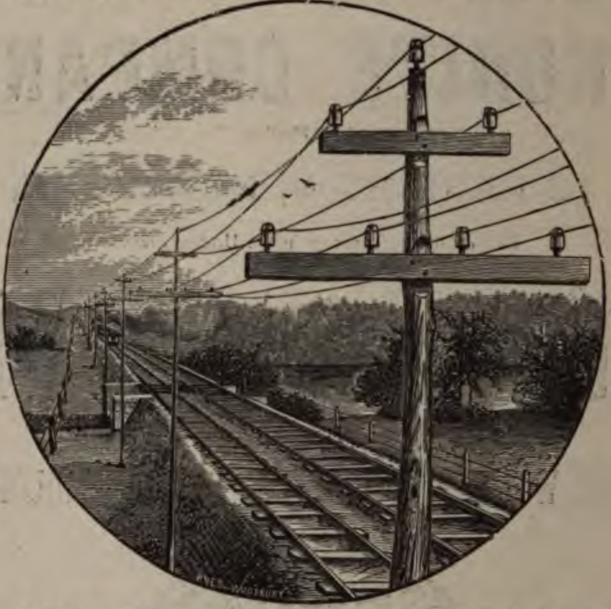

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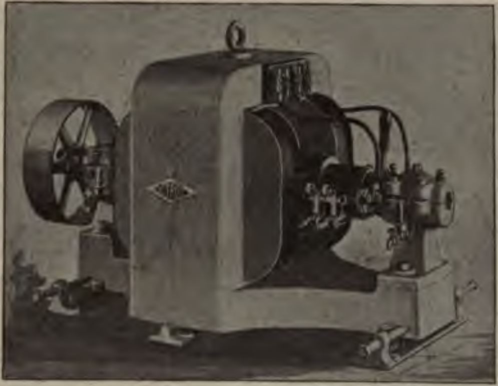

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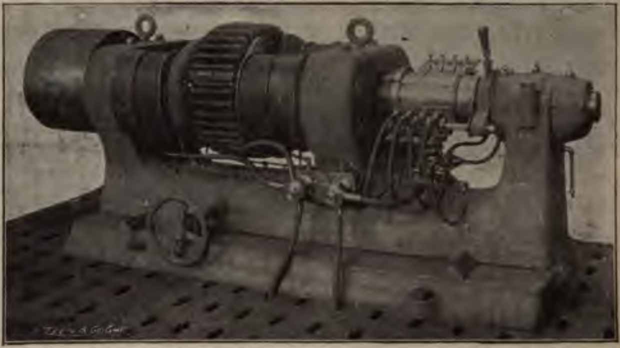

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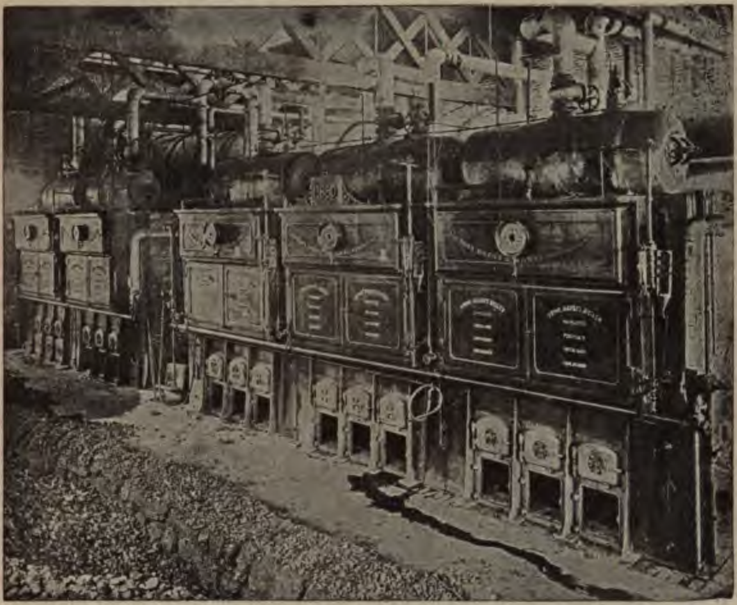

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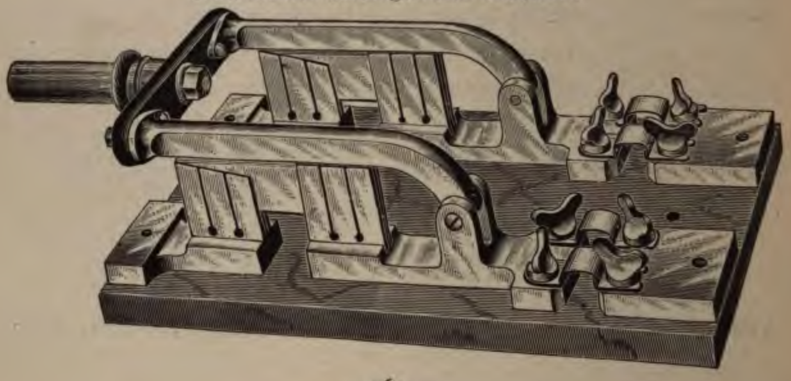

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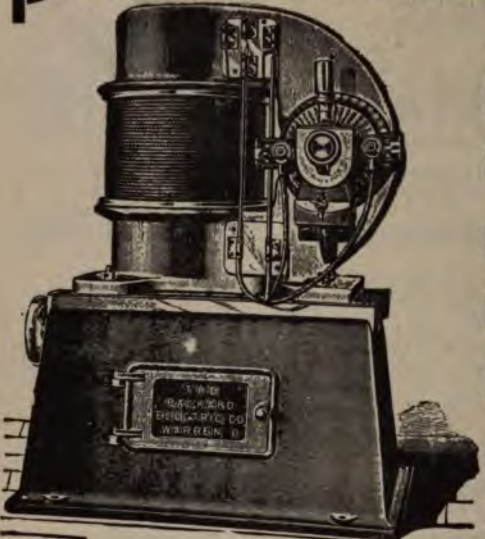
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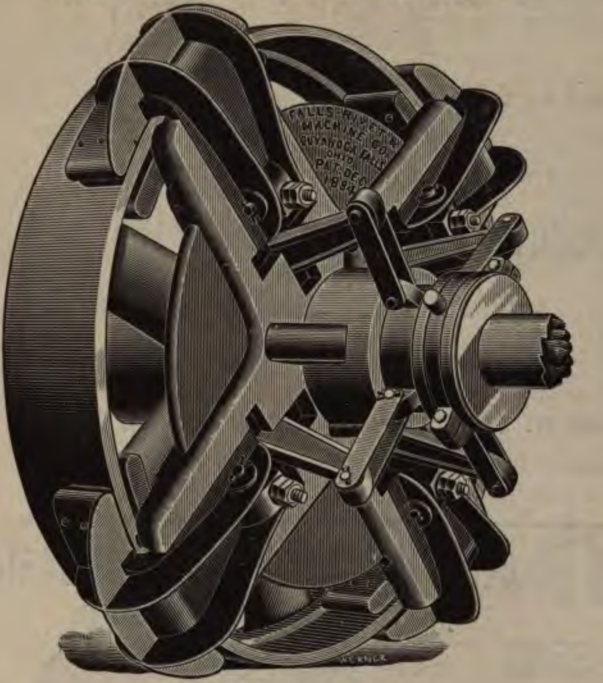

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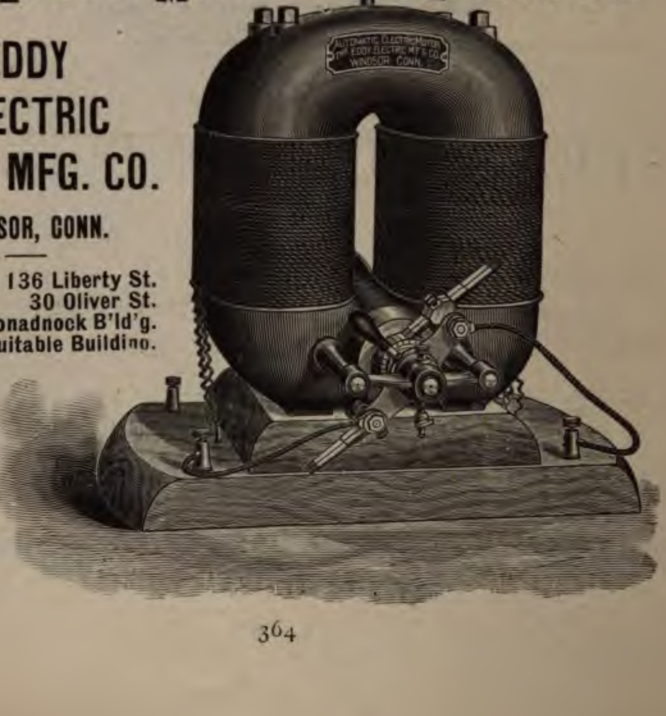
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